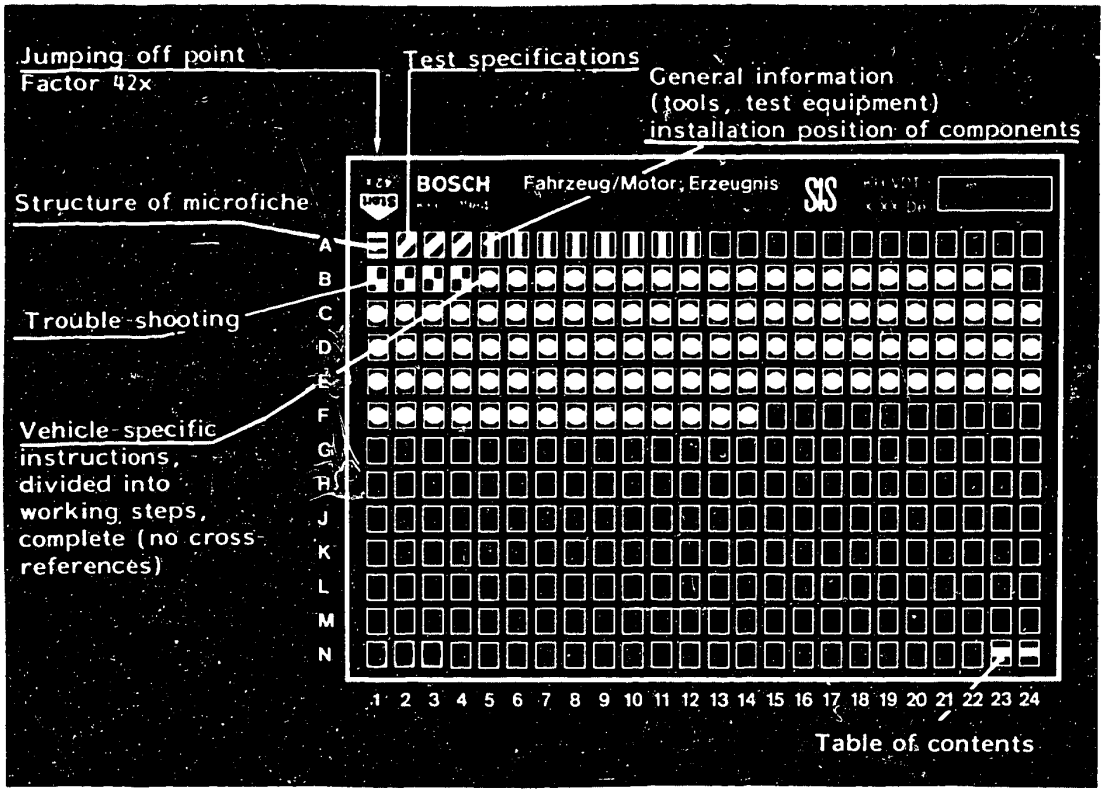
Microfiche layout



1. Read from left to right

2. Title of microfiche (appears on each coordinate)

E16	Product/assembly/test step Vehicle/engine	

Coordinate

3. Limits of section



Beginning | Mid-section | End | One-page section

4. Purely vehicle-specific passages in the text are marked with a vertical bar.

5. Reference to relevant working steps in the test specifications, e.g. coordinate C6.

C6

1. Test specifications

C9

1.1 Idle speed for Golf, Santana, Jetta and Caddy

1.5 and 1.6 l diesels to 9/82	825 ±25 min^{-1}
1.6 l diesels and turbo-diesels from 9/82	950 ±30 min^{-1}
Vehicles with automatic transmission	930 ±30 min^{-1}

1.1.1 Idle speed for Audi 80:

1.6 l diesel and turbo-diesel	950 ±30 min^{-1}

C19

1.2 Nozzle opening pressure:

Diesel	
Pressure of new nozzles	130 +8 bar
Pressure of worn nozzles	120 bar
Turbo-diesel	
Pressure of new nozzles	155 +8 bar
Pressure of worn nozzles	140 bar

D1

1.3 Filter check

max. permissible differential pressure	0.3 bar

D 15

1.4 Compression:	
Set value	34 bar
Lower limit due to wear	28 bar
Permissible cylinder deviation	max. 5 bar

D 15

1.5 Pressure drop:	max. perm. 25%

F 11

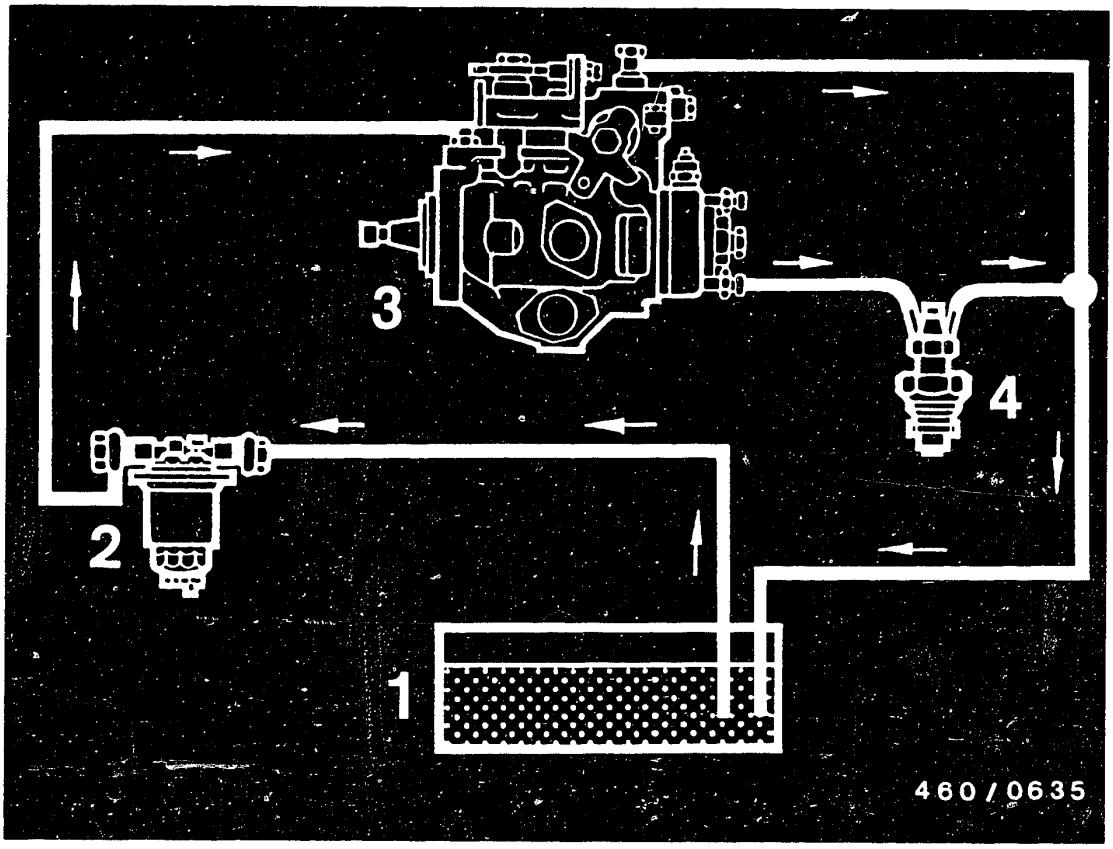
1.6 Pump/engine position agreement:	
Engine position:	1st cyl. at TDC
Check value, diesel	
Pump position:	0.78 ... 0.88 mm after BDC
Setting value	
Pump position:	0.86 ±0.02 mm after BDC
Check value, turbo-diesel	
Pump position:	0.86 ... 0.97 mm after BDC
Setting value	
Pump position:	0.95 ±0.02 mm after BDC

F 16

1.7 Charging-air pressure:	0.64 ... 0.72 bar
1.8 Secondary-air valve pressure:	0.81 +0.05 bar

1.9 Torques

Injection pump sprocket	45 Nm
Injection pump mounting bolts	25 Nm
Fuel lines	25 Nm
Screw plug	15 Nm
Nozzle holder mounting bolts	70 Nm
Sheathed-element glow plugs	40 Nm
Camshaft sprocket	45 Nm
Support bracket on injection pump (Mounting bolt)	25 Nm
Turbocharger/exhaust manifold mounting bolts	70 Nm
Exhaust manifold/engine block	25 Nm
Exhaust pipe	40 Nm
Vent screw	15 Nm



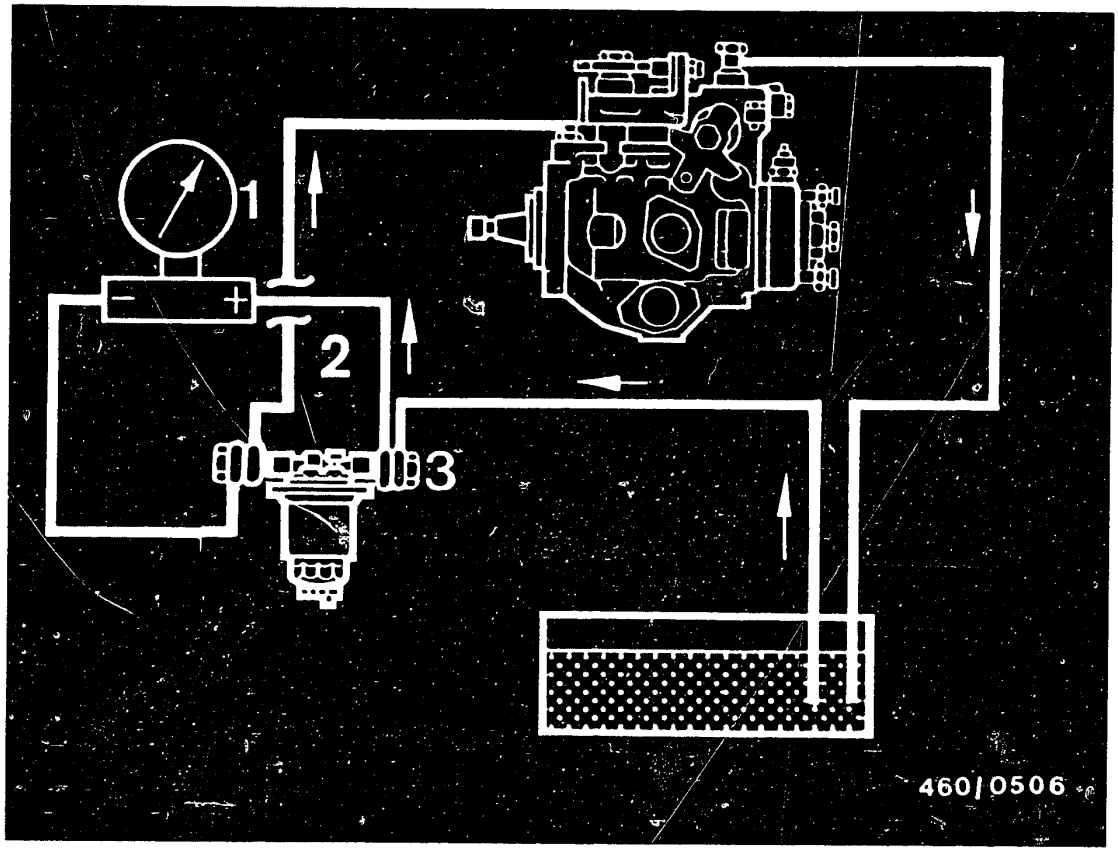
1 = Fuel tank
2 = Fuel filter
3 = Distributor-type injection pump
4 = Injection nozzles

2. Line diagrams for naturally-aspirated and turbocharged engine

2.1 Fuel line diagram

The fuel lines are connected according to the above diagram.

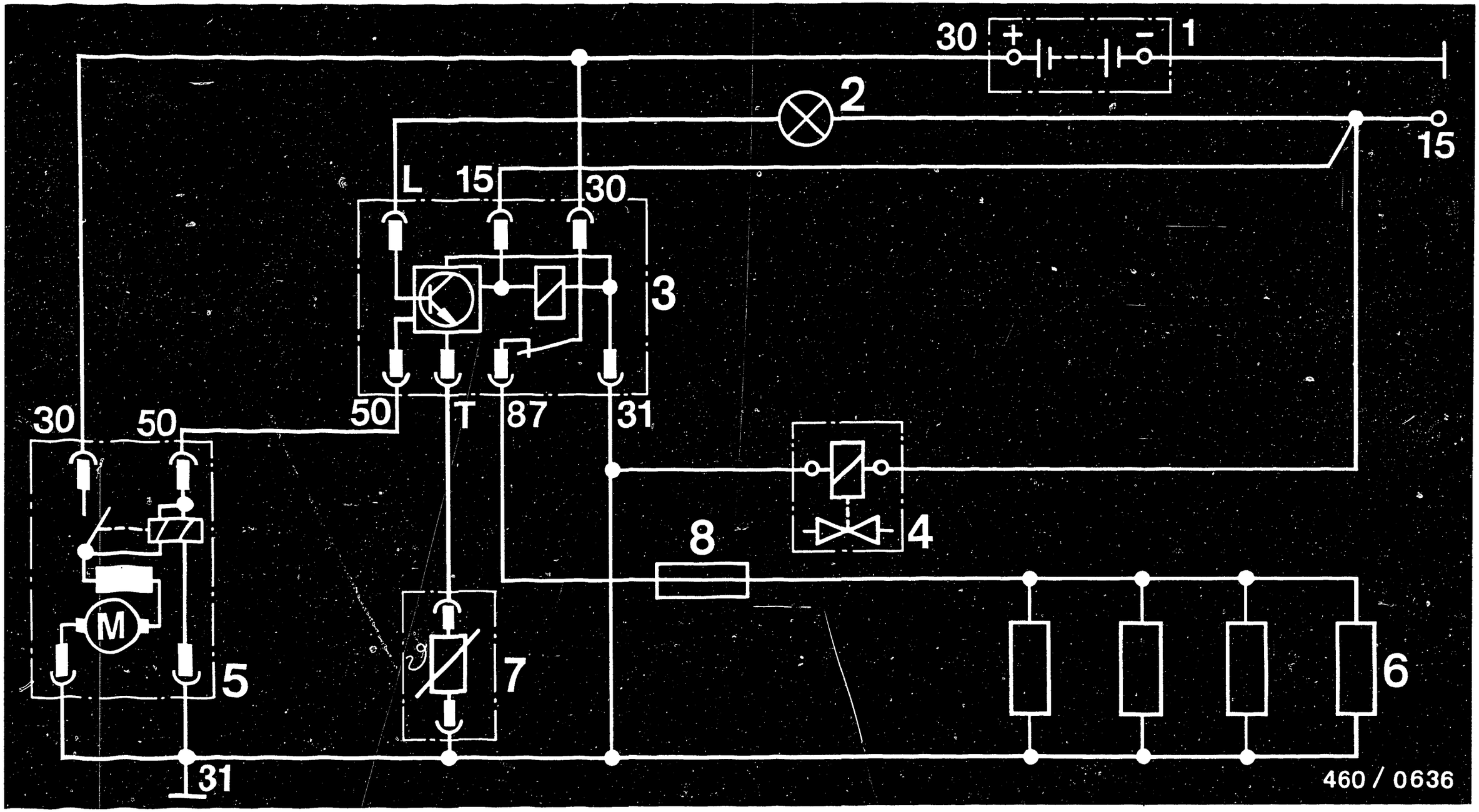
Fuel flows in the direction of the arrow.



1 = Differential pressure gauge
2 = Filter discharge
(Use inlet union and
extra-long hollow bolt, 2 443 456 020)
3 = Filter inlet
(Use inlet union and
extra-long hollow bolt, 2 443 456 020)

2.2 Connection diagram for filter check

Connect differential pressure gauge to corresponding fittings on fuel filter.



1 = Battery
2 = Visual indicator
3 = Glow duration control unit
4 = Solenoid-operated valve
5 = Starter
6 = Glow plugs
7 = Temperature sensor
8 = 80 A fuse

3. Wiring diagram for pre-heating system

A7 Wiring diagram for pre-heating system Audi 80 and VW, diesel and turbo-diesel →

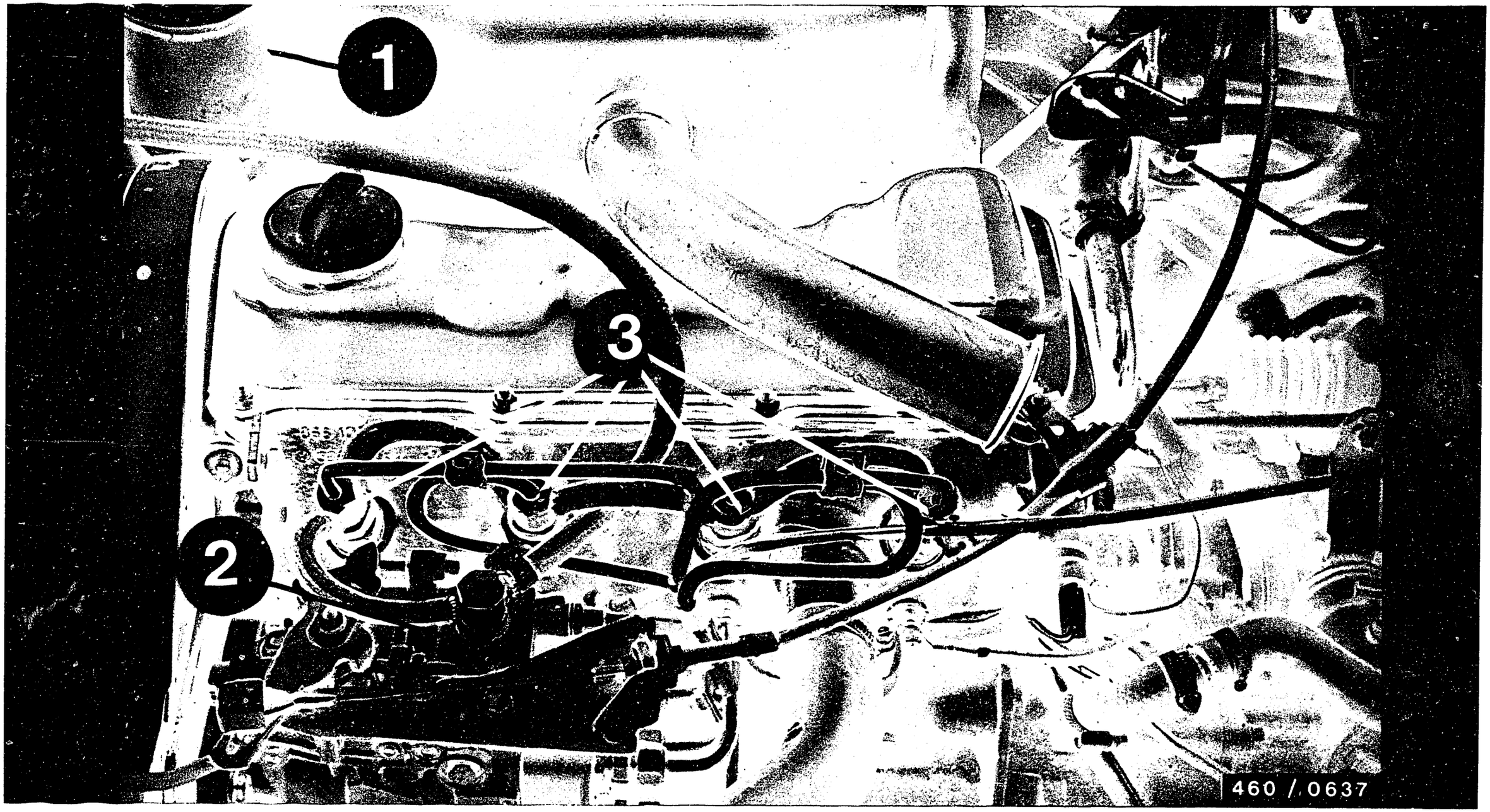
A8 Wiring diagram for pre-heating system Audi 80 and VW, diesel and turbo-diesel ←

4. Test instruments and tools

Description	Order number	Use
Gear puller	KDEP 1118	Pulling injection pump sprocket
Securing pin	KDEP 1122	Securing injection pump sprocket
Arm bracket	KDEP 1116	Locking camshaft sprocket
Toothed belt tension checker	KDEP 1121	Checking toothed belt tension
Setting straightedge	KDEP 1117	Locking camshaft
Box wrench	KDEP 1115	Removing injection lines
Measuring tool	KDEP 1085	Pump/engine position agreement
Miniature dial indicator Graduation: 1/100 mm	commercially available, e.g. Hahn & Kolb 7000 Stuttgart Order No. 33003 with adapter KDEP 1127	Pump/engine position agreement
Pressure measuring tool or pressure gauge 0 ... 1.6 bar	KDJE-P 100 e.g. Wika No. 4184	Checking charging-air pressure

Test instruments and tools (cont'd.)

Description	Order number	Use
Nozzle tester	EFEP 60 H 0 681 200 502	Checking nozzles
Compression tester Additional nipple for compression tester	commercially available commercially available Order No. 622 010 3219 Motor-Meter GmbH Daimler-Str. 6 7250 Leonberg	Checking engine compression
Compression loss tester	EFAW 210 A 0 681 001 901	Checking engine pressure loss
Tachometer	commercially available	Adjusting engine speed
Differential pressure gauge	commercially available Order No. NG 160/311-911/ - 1.0 + 4.0 bar Henni Co. Nauheimer Str. 78-80 7000 Stuttgart 50	Checking filter
Exhaust gas tester	0 681 169 039 0 681 169 038	Testing exhaust gas
Nut driver	Hazet 2587	Tensioning toothed belts

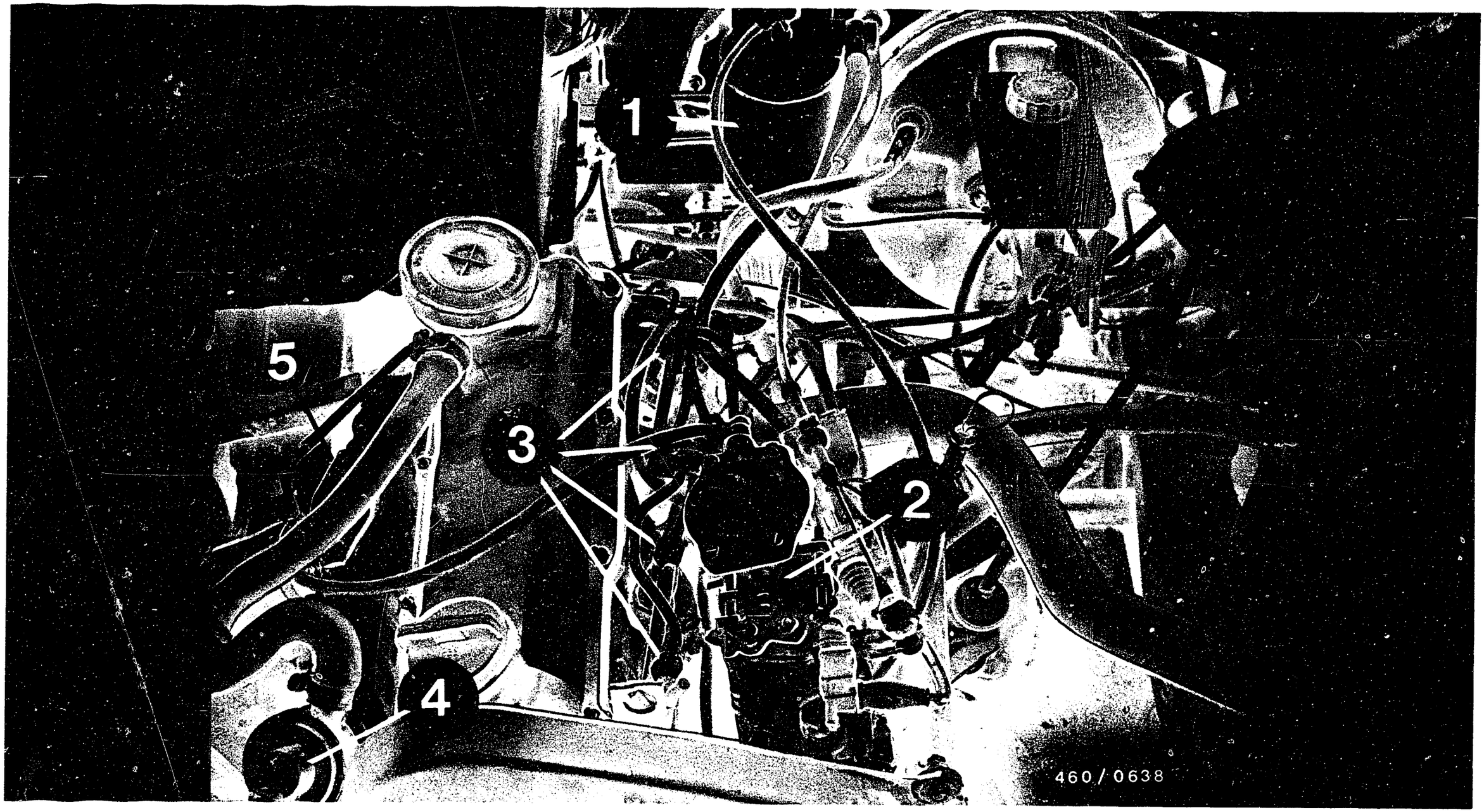


1 = Fuel filter

2 = Injection pump

3 = Nozzles

5. Component locations (transverse engine)



1 = Fuel filter 2 = Injection pump 3 = Nozzles 4 = Secondary-air valve 5 = Turbocharger (not shown)

Component locations (longitudinal turbocharged engine)

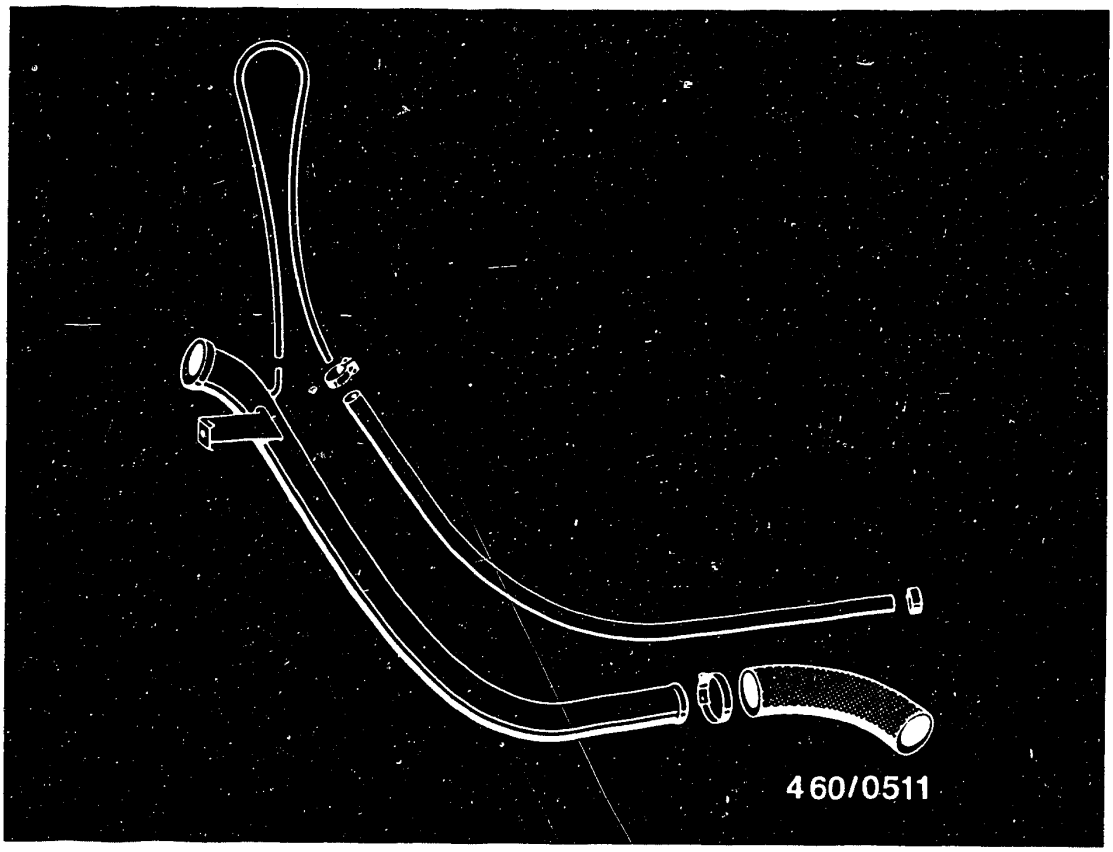
6. Troubleshooting

Customer complaint (symptom)

1. Engine does not start or is difficult to start when warm	2. Engine does not start or is difficult to start when cold	3. Engine hunts when idling	4. Uneven idling when warm	5. Engine misfires at driving speed	6. Driving performance unsatisfactory	Cause (Component fault)	Coordinates
•	•			•	•	Tank empty; tank vent clogged	B 5
	•					Cold-start accelerator not working	B 6
	•		•			Injection sequence not same as ignition sequence	B 7
				•		Overflow valve restricted	B 9
•	•					Shutoff device defective	B 10
		•		•	•	Hollow bolts in supply and return lines clogged	B 14
•	•		•	•	•	Air in fuel system	B 15
	•					Heavy paraffin build-up in filter	B 17
•	•			•	•	Connections loose; lines leaking or broken	B 21
•	•			•	•	Supply lines clogged	B 24
•	•			•	•	Injection lines clogged or restricted	B 24
					•	Engine air filter clogged	C 8
			•			Incorrect idling speed	C 9
•	•		•		•	Nozzle defective	C 19
	•		•		•	Incorrect nominal start of pump delivery	F 11
•	•			•	•	Fuel filter clogged	D 1
	•					Pre-heating system defective	D 4
					•	Timing device defective	D 14
	•		•			Engine compression poor or uneven	D 15
					•	Maximum engine speed misadjusted	E 2
•	•	•	•	•	•	Injection pump (controller) defective or misadjusted	E 2
					•	Check tightness and charging-air pressure of turbocharger	F 16

Troubleshooting (cont'd.)

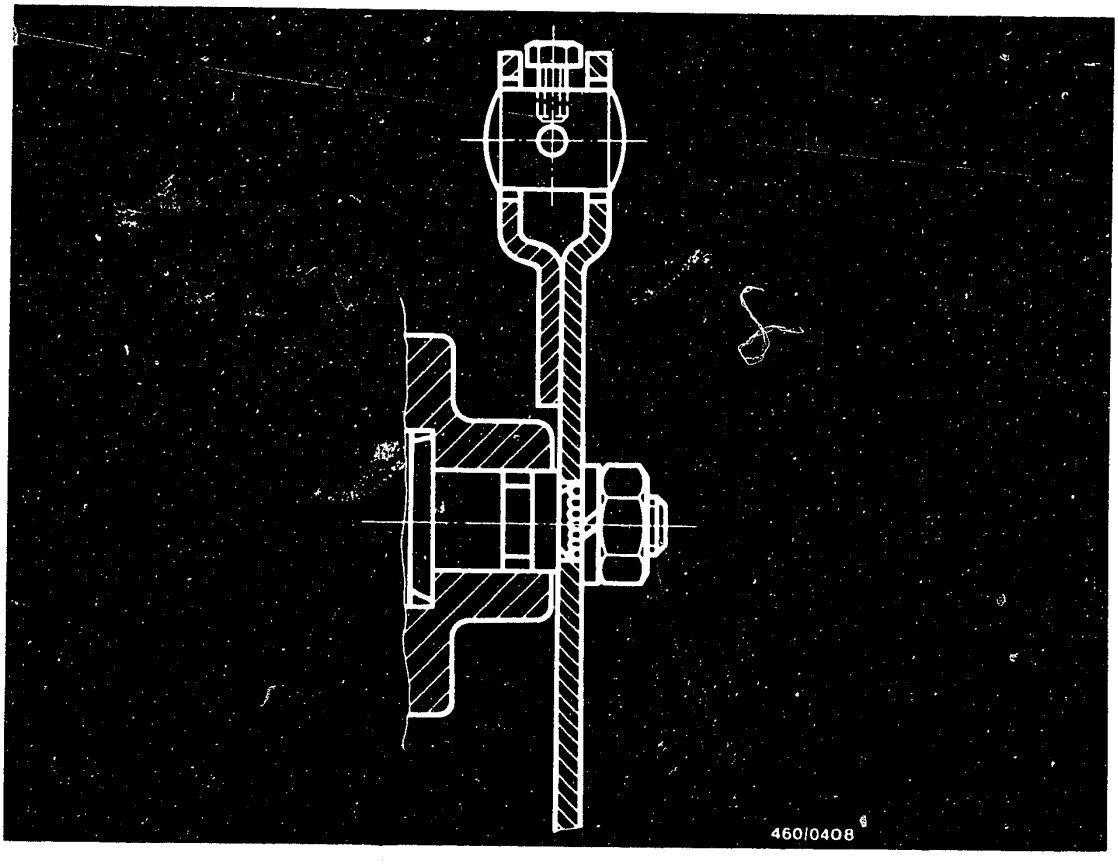
7. Excessive fuel consumption	8. Engine runs on	9. Engine runs hard; black exhaust in full-load range; possible drop in performance	10. White exhaust in full-load range	11. Incorrect engine speed	12. Engine does not accelerate when cold	13. Distributor-type injection pump runs too hot	Cause (Component fault)	Coordinates
		•		•			Tank empty; tank vent clogged	B 5
				•			Cold-start accelerator not working	B 6
	•		•	•			Injection sequence not same as ignition sequence	B 7
						•	Overflow valve restricted	B 9
•							Shutoff device defective	B 10
		•	•	•			Hollow bolts in supply and return lines clogged	B 14
		•		•			Air in fuel system	B 15
				•			Heavy paraffin build-up in filter	B 17
•							Connections loose; lines leaking or broken	B 21
		•		•			Supply lines clogged	B 24
		•		•			Injection lines clogged or restricted	B 24
	•						Engine air filter clogged	C 8
			•				Incorrect idling speed	C 9
	•						Nozzle defective	C 19
•		•	•		•		Incorrect nominal start of pump delivery	F 11
		•		•			Fuel filter clogged	D 1
	•	•					Timing device defective	D 14
•					•		Engine compression poor or uneven	D 15
			•				Maximum engine speed misadjusted	E 2
•	•	•	•	•	•	•	Injection pump (controller) defective or misadjusted	E 2



7. Checking tank ventilation

Remove fuel cap.
If this cures the problem, tank ventilation system is defective.

Remove tank vent lines and check for clogs or restrictions. Check filler neck on tank if necessary.

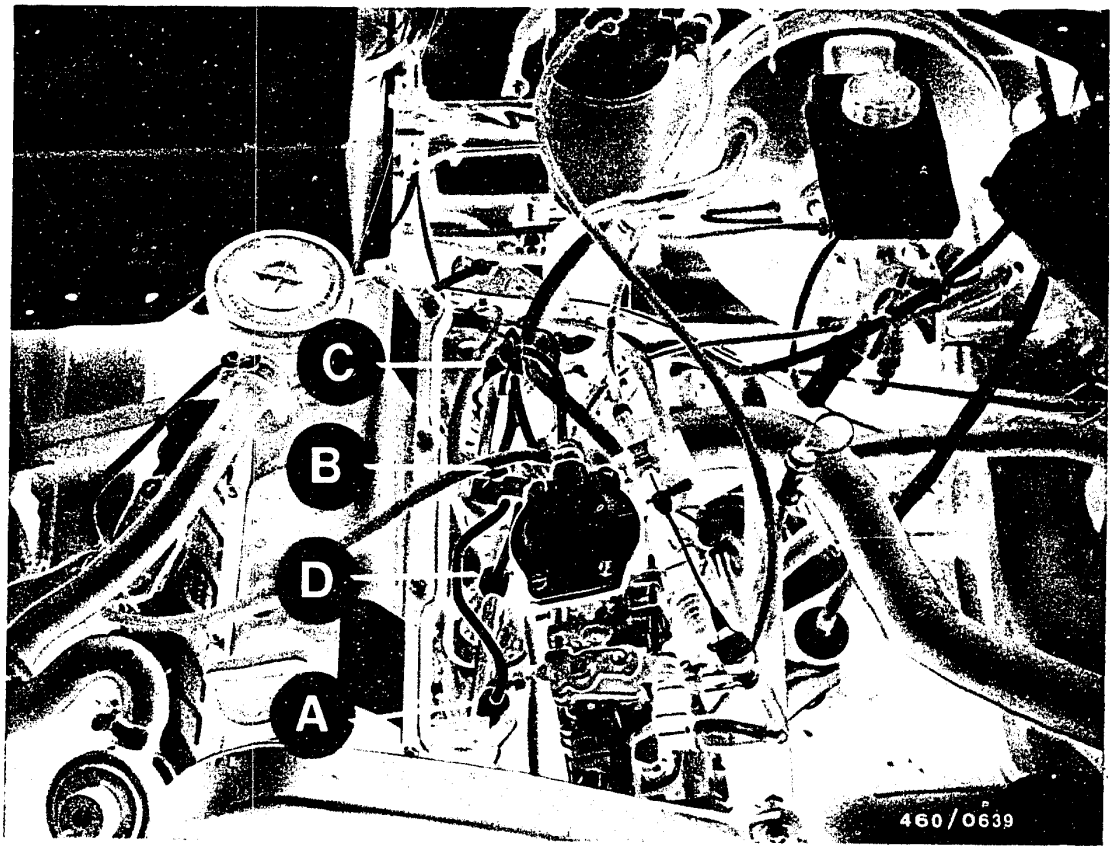


8. Checking operation of cold-start accelerator

Check whether the stop lever is in its initial position with cold-start accelerator disengaged.

With cold-start accelerator engaged, the stop lever must rest against the stop bracket.

If the stop lever remains in a different position, the injection pump must be removed.

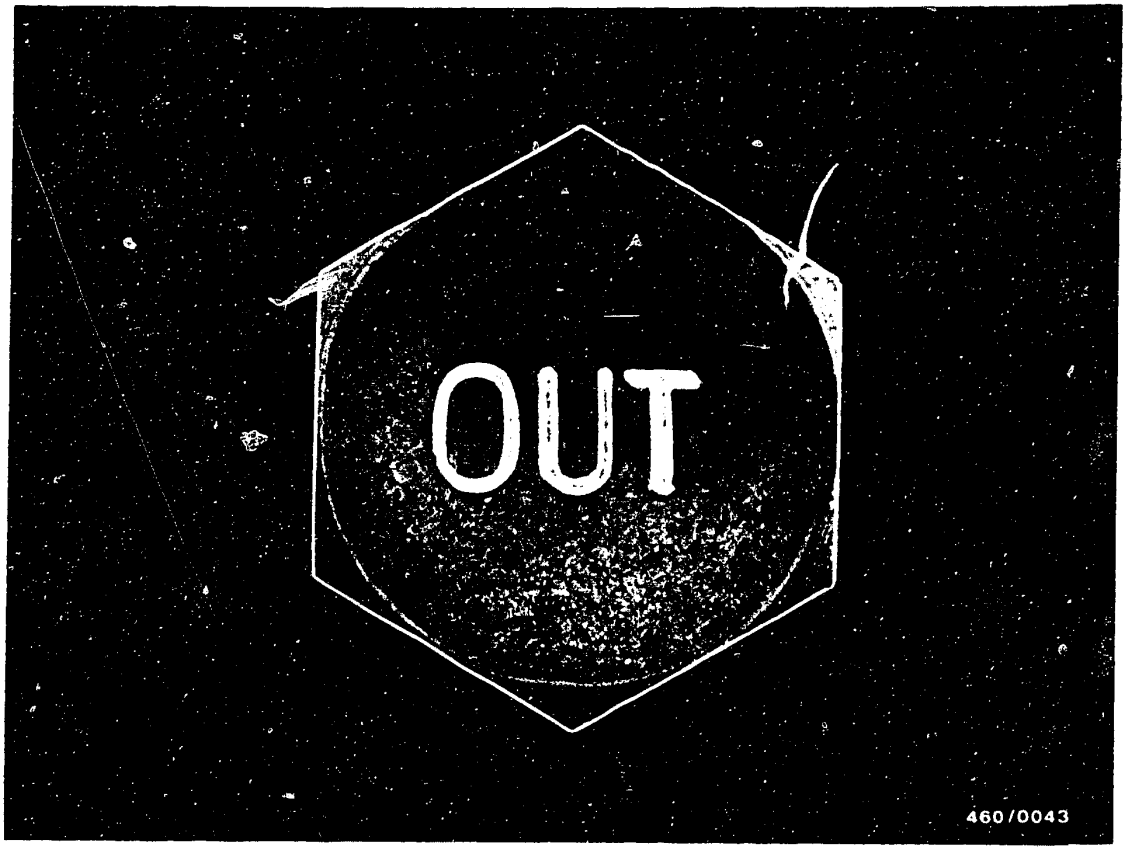


9. Checking routing of delivery lines

The delivery lines are connected to each other by hose clamps so that the outlet ends cannot be switched.

If the problem persists, check the routing of the lines as shown in the photo above.

The injection pump outlet configuration for the engine cylinders is indicated by the letters A - D.

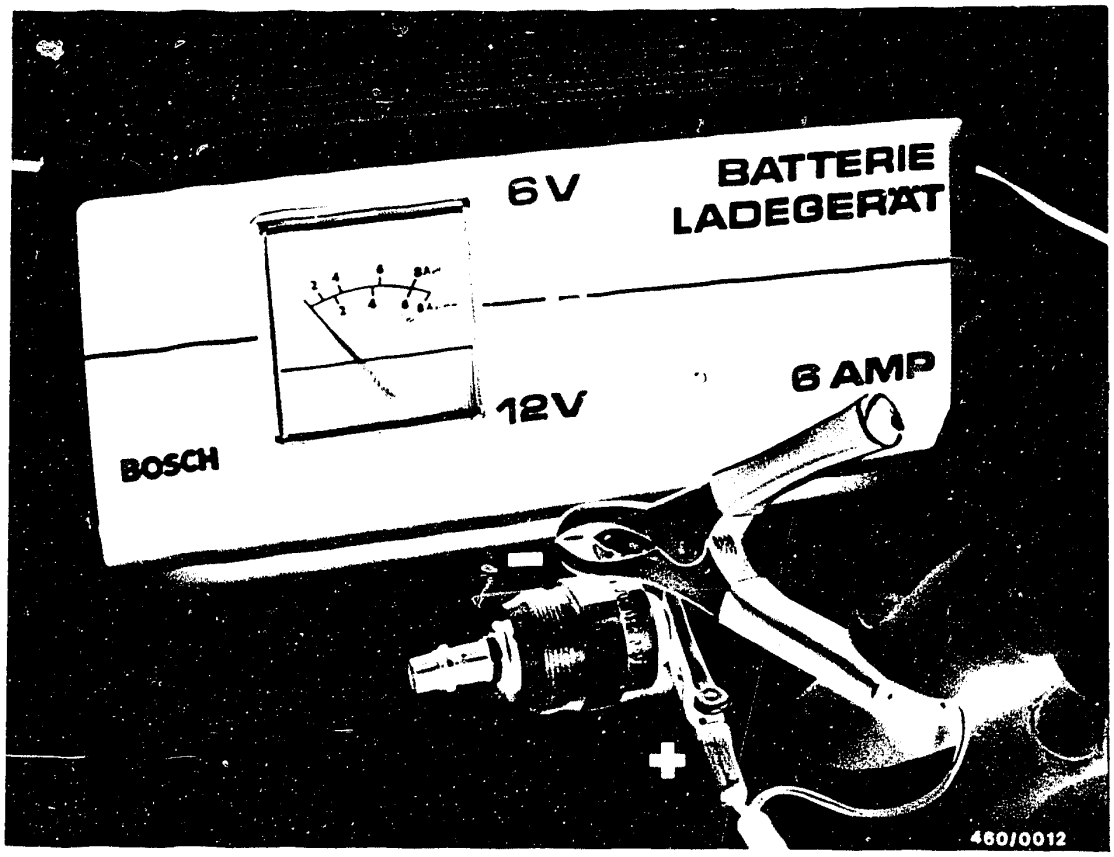


10. Checking overflow valve

Remove injection pump overflow valve (marked "OUT").

Visually inspect wire mesh screen for contamination

If problem persists, replace valve.



11. Checking operation of shutoff device

11.1 Engine does not start

Check for voltage (min. 10 V) across solenoid with glow plug and start switch on (drive position).
If voltage is good, disconnect injection lines and remove solenoid-operated valve
Make sure valve is c l e a n !
Check for proper operation of valve when removed.

Note:
As solenoid-operated valve is normally fuel-cooled, apply voltage only briefly.



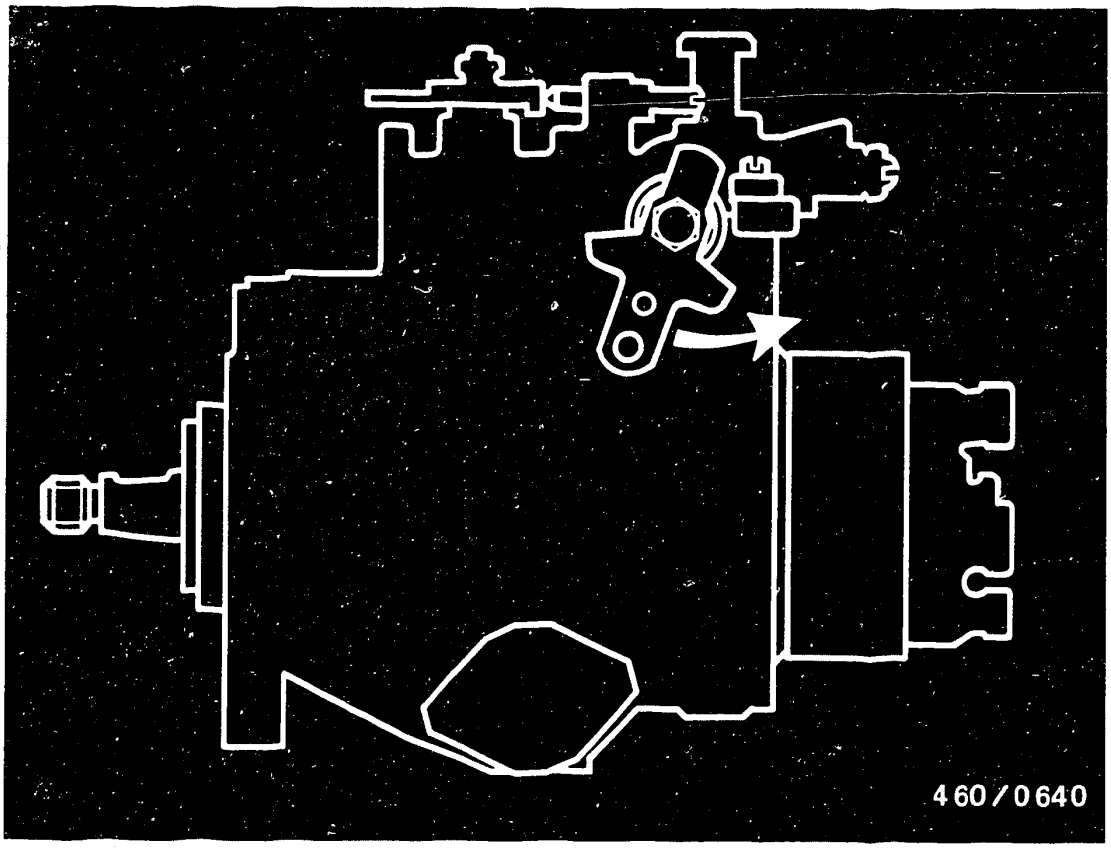
11.2 Engine runs on

The solenoid-operated valve (arrow) must carry no voltage when the pre-heating start switch is in the "Stop" position, i.e. fuel flow to the distributor piston is interrupted.

If the engine continues to run even though the solenoid is not supplied with voltage, it can be shut off as follows:

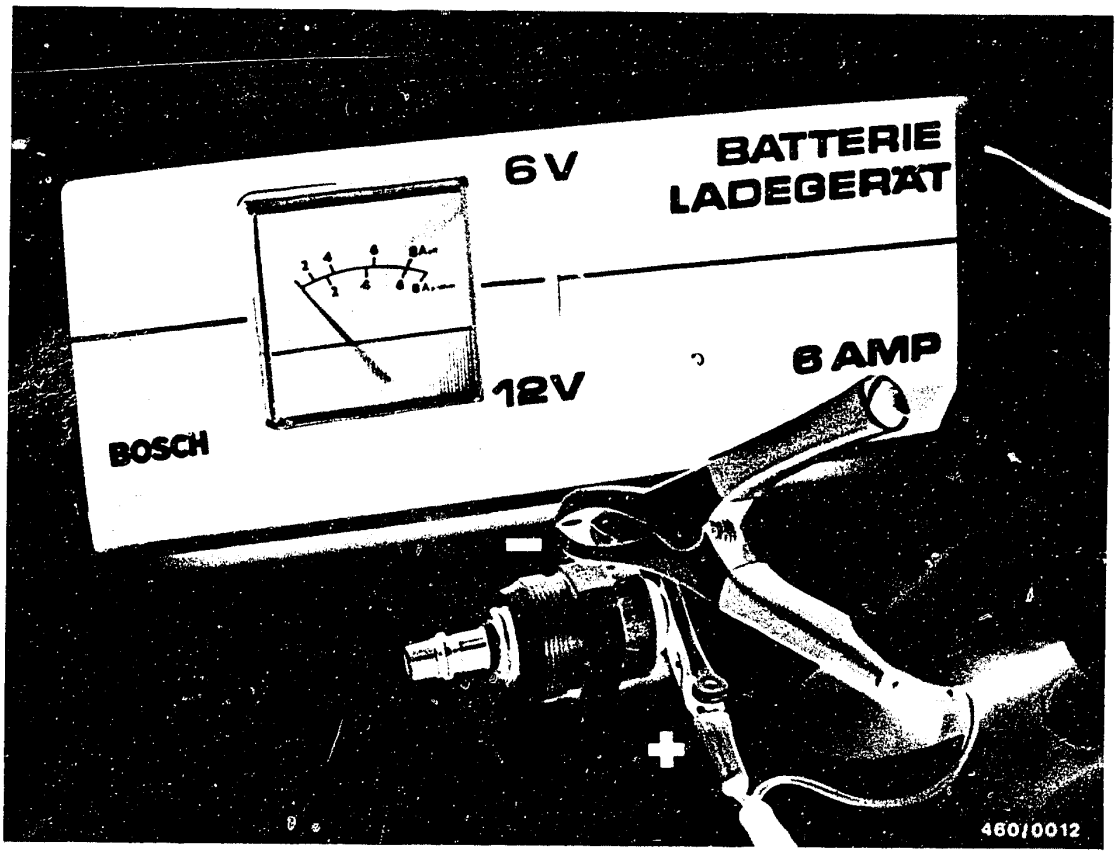
- Vehicles with standard transmission

 Engage 3rd or 4th gear.
 Step hard on brake and let out clutch.



- Vehicles with automatic transmission

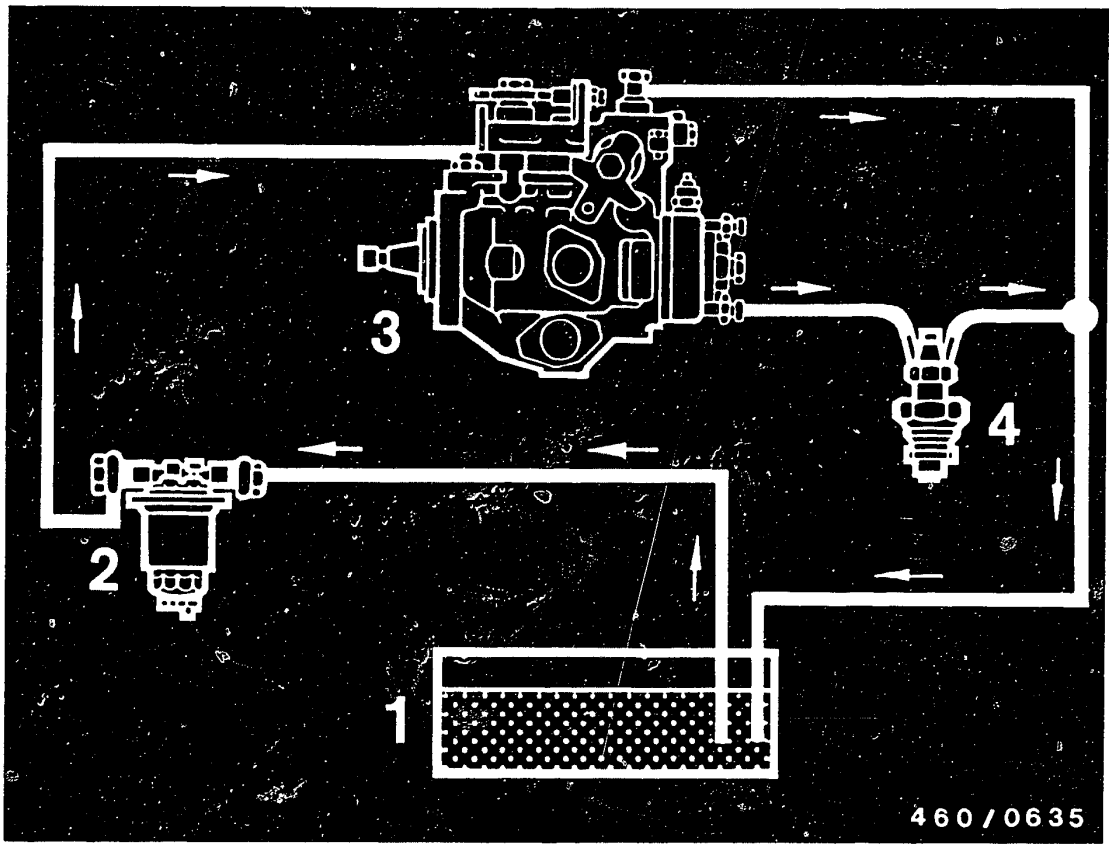
 If the engine does not stop when the ignition is switched off (because the solenoid-operated valve does not interrupt the flow of fuel), stop the engine by turning the mechanical shutoff device in the direction of the arrow.



21.3 Check of solenoid-operated valve

Disconnect injection lines and remove solenoid-operated valve.
Make sure valve is c l e a n !
Check for proper operation of valve when removed.

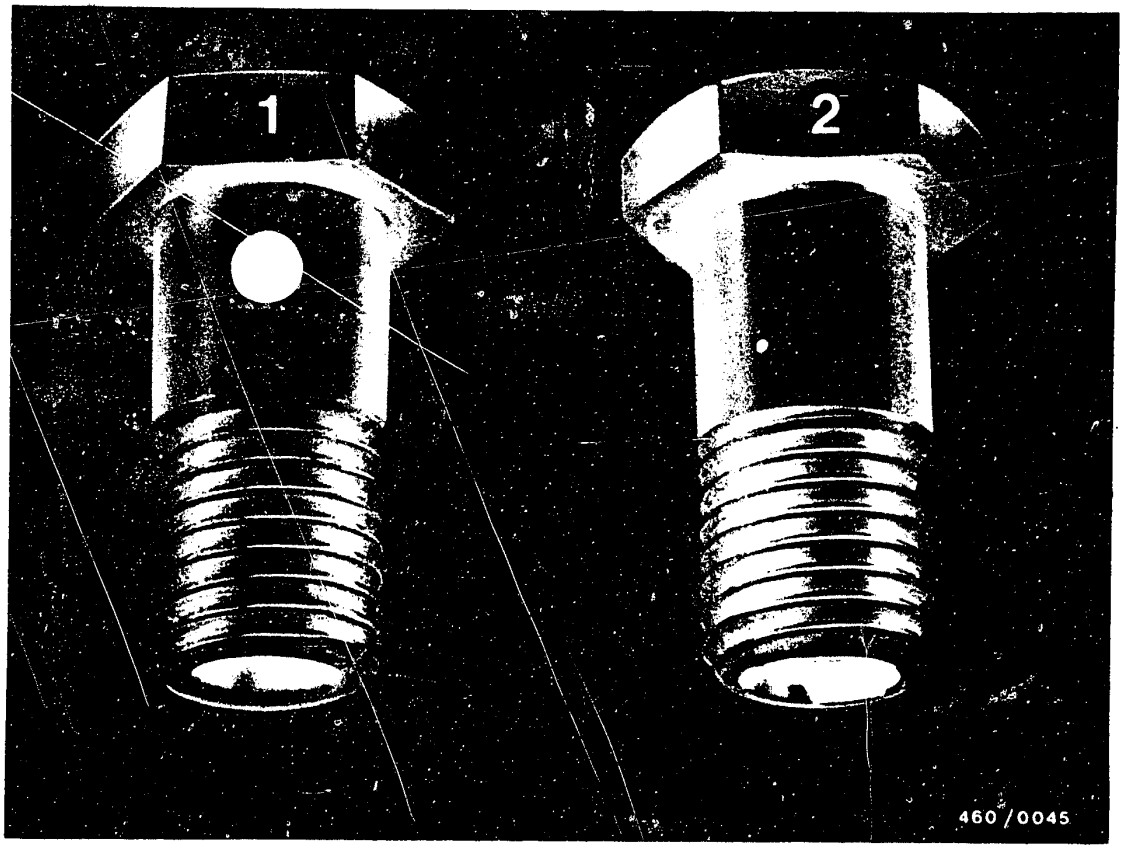
Note:
As solenoid-operated valve is normally fuel-cooled, apply voltage only briefly.
Visually inspect valve seat in distributor head.



1 = Fuel tank
2 = Fuel filter
3 = Distributor-type injection pump
4 = Nozzles

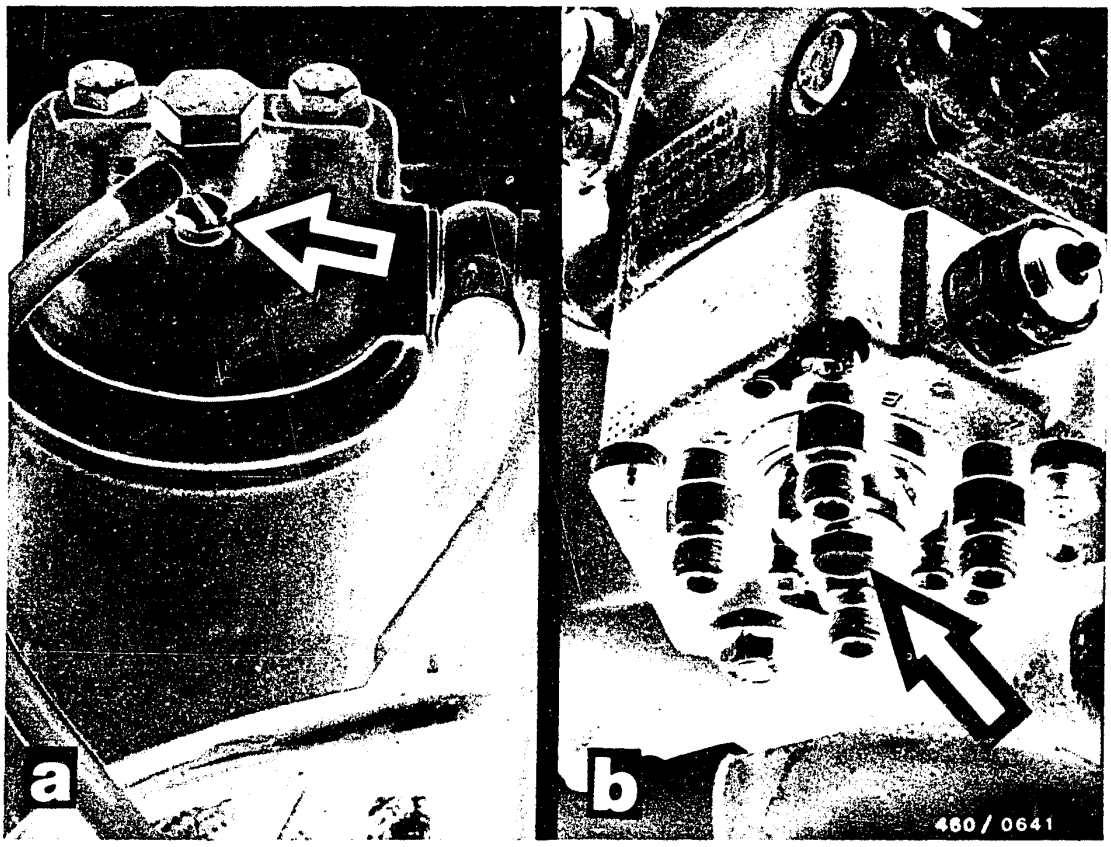
12. Fuel line connection diagram

The fuel lines are connected as shown in the diagram above.
Fuel flows in the direction of the arrow.



When making injection pump connections be sure that the hollow bolt for fuel supply (1) and the throttle screw for fuel return (2) are not switched.

The throttle screw is located on the pump cover and is marked "OUT".

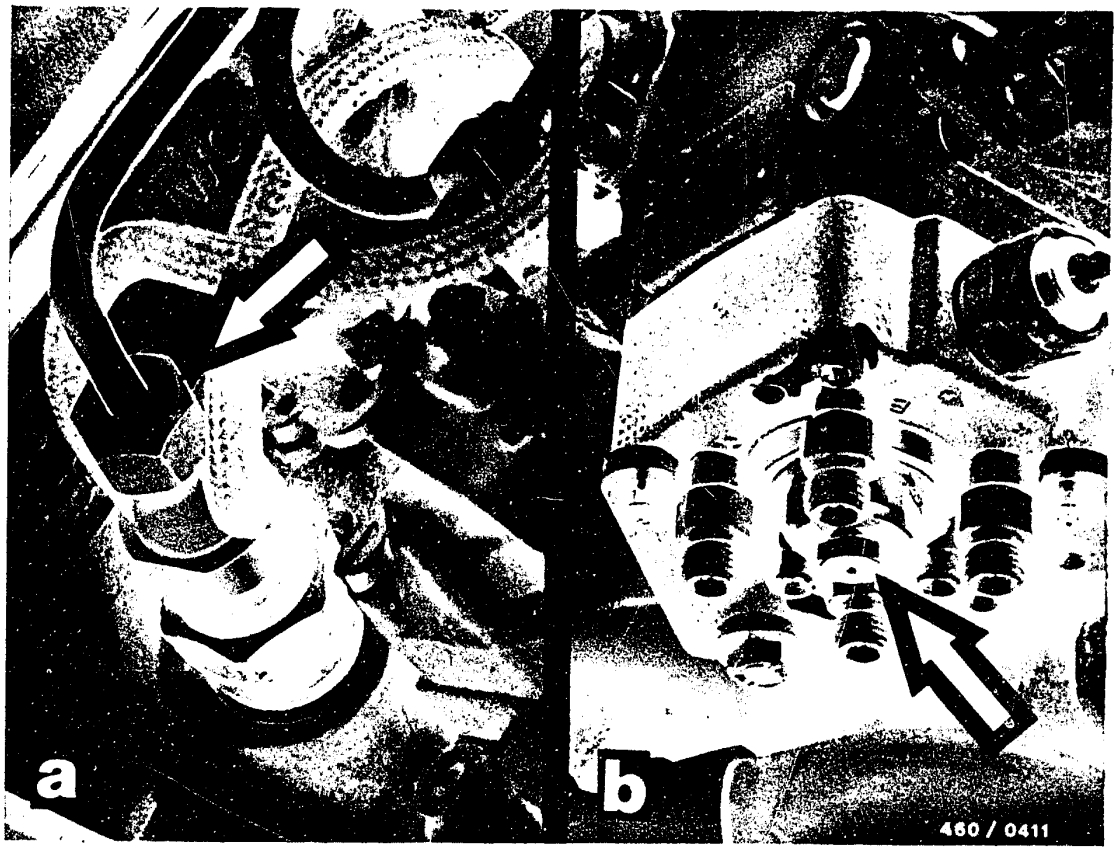


13. Bleeding fuel system

Fill fuel filter and injection pump with diesel fuel.

Tighten vent screw on fuel filter (shown at arrow in Fig. a).

Unscrew vent screw on injection pump several turns (shown at arrow in Fig. b).



Loosen delivery line union nuts on nozzle holders (shown at arrow in Fig. a).

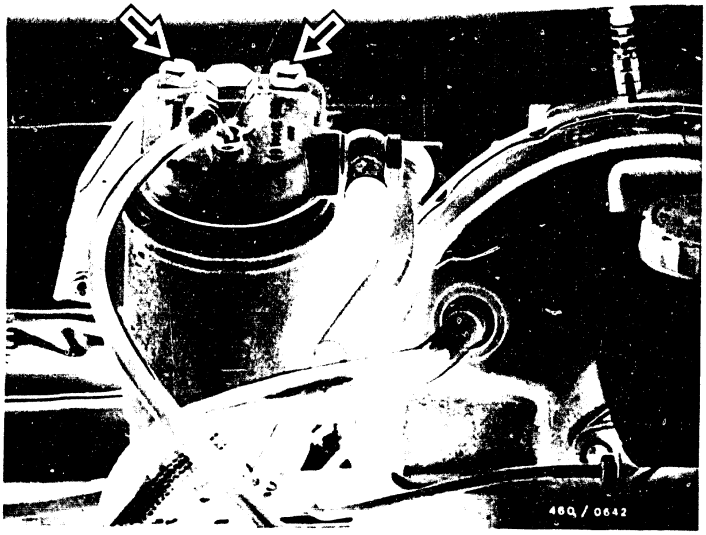
Operate starter without pre-heating.

Tighten vent screw when fuel escaping through injection pump vent hole (shown at arrow in Fig. b) is free of bubbles.

Continue to operate starter until fuel escapes at nozzle holder union nuts.

Tighten union nuts.

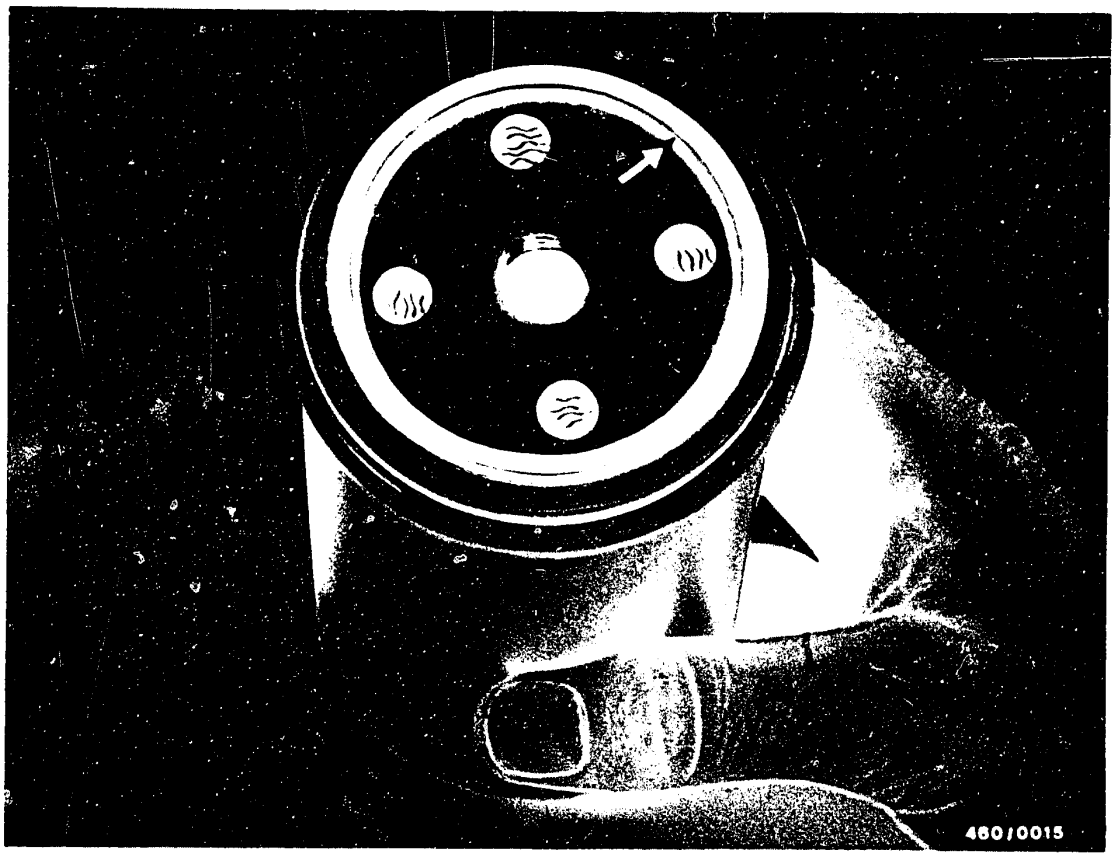
Operate starter until engine starts.



14. Replacing fuel filter and draining water

14.1 Replacing fuel filter

- Remove hoses from filter top.
- Remove cover mounting bolts (arrows).
- Unscrew filter and empty.
- Remove tight filter with special wrench, e.g. Matra W 167.



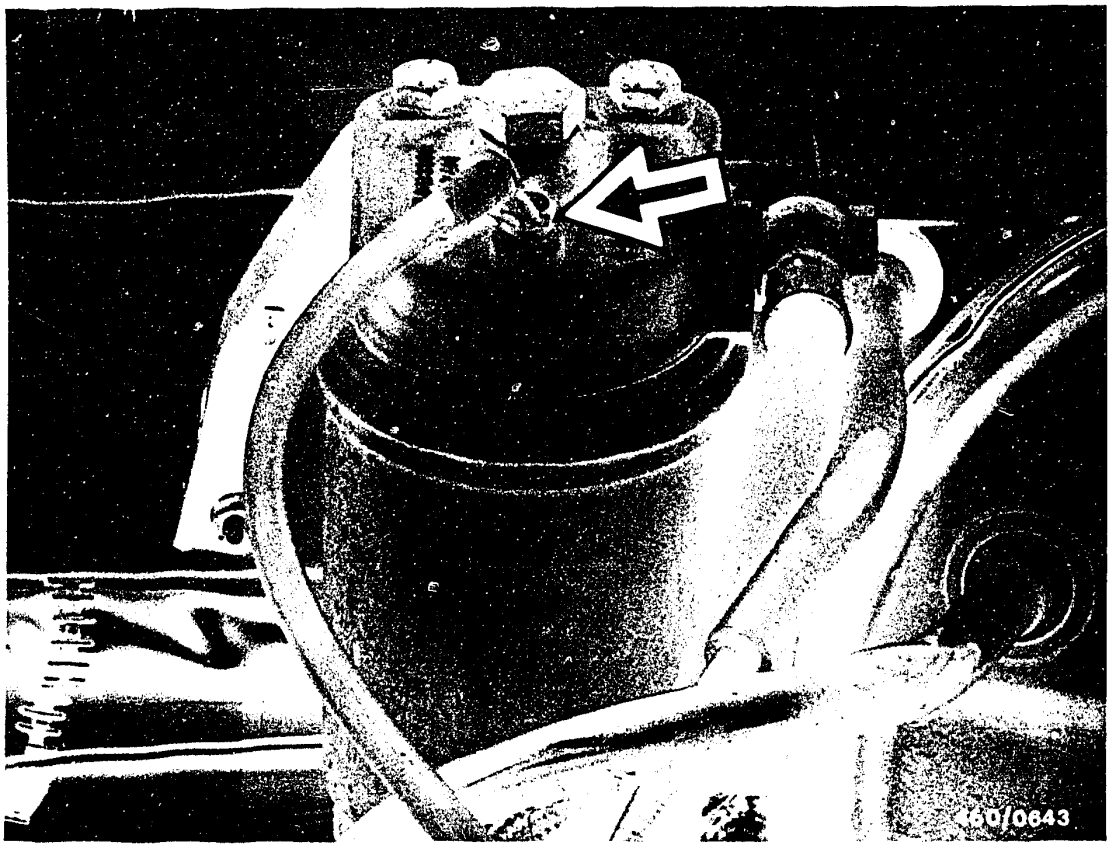
Apply a coating of diesel fuel to rubber seal (arrow) of new filter.

Screw filter into cover hand-tight.

Check fuel filter for tightness.

Accelerate engine several times; at idle, fuel flowing through transparent line must be free of bubbles.

When using winterized fuel, add kerosene to fuel as specified by vehicle manufacturer.

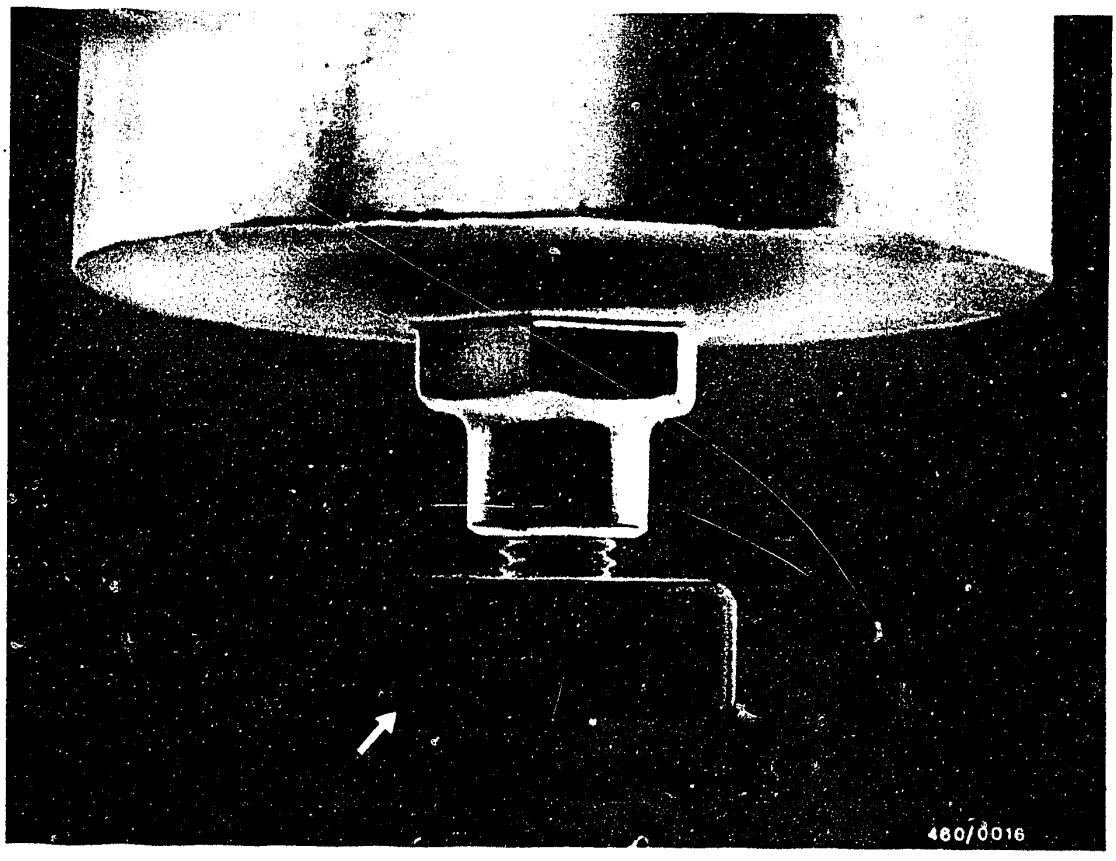


14.2 Draining water from fuel filter

Follow one of these procedures, depending on filter design:

Unscrew vent screw (arrow) on filter cover several turns.

If cover has no vent screw, disconnect return line from injection pump.



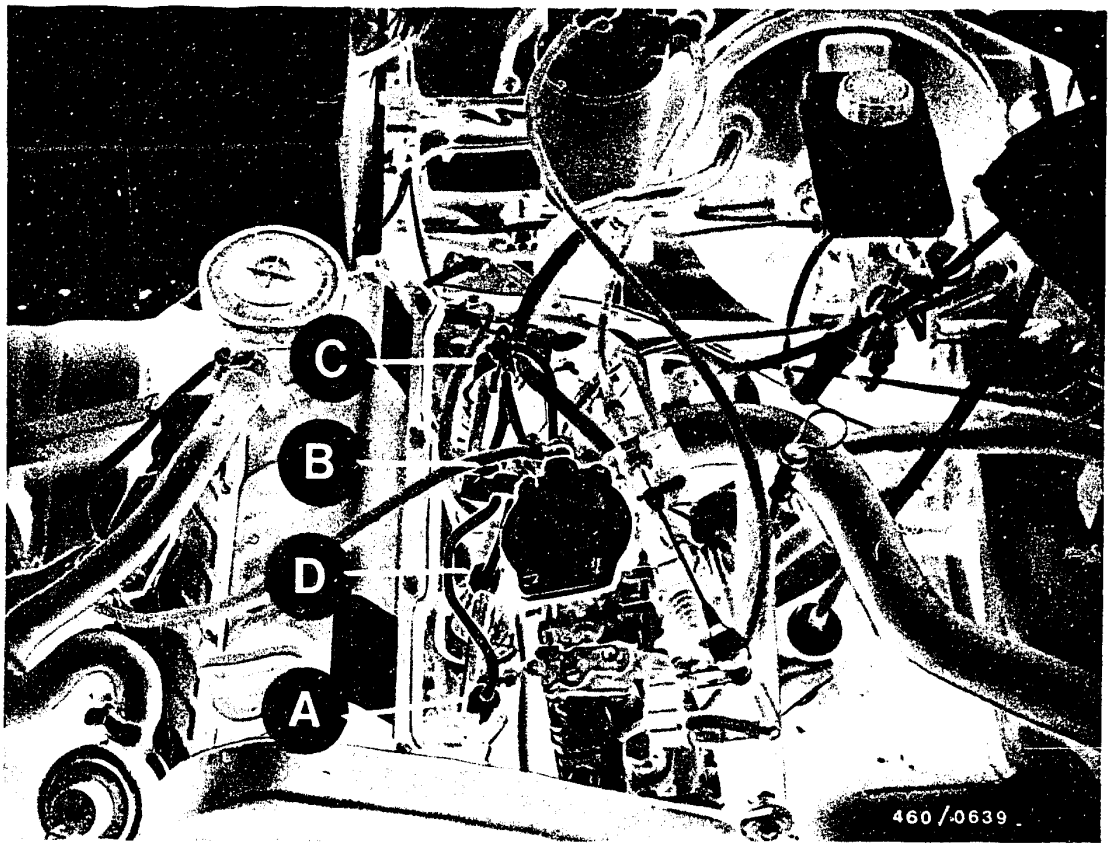
Loosen drain plug on bottom of filter and allow water to drain.

Catch water in suitable container.

Retighten drain and vent screws and check for tightness.
Bleed fuel filter if necessary.

Note:

If designs without vent screw will not drain, loosen mounting screw of one fuel line on filter flange.



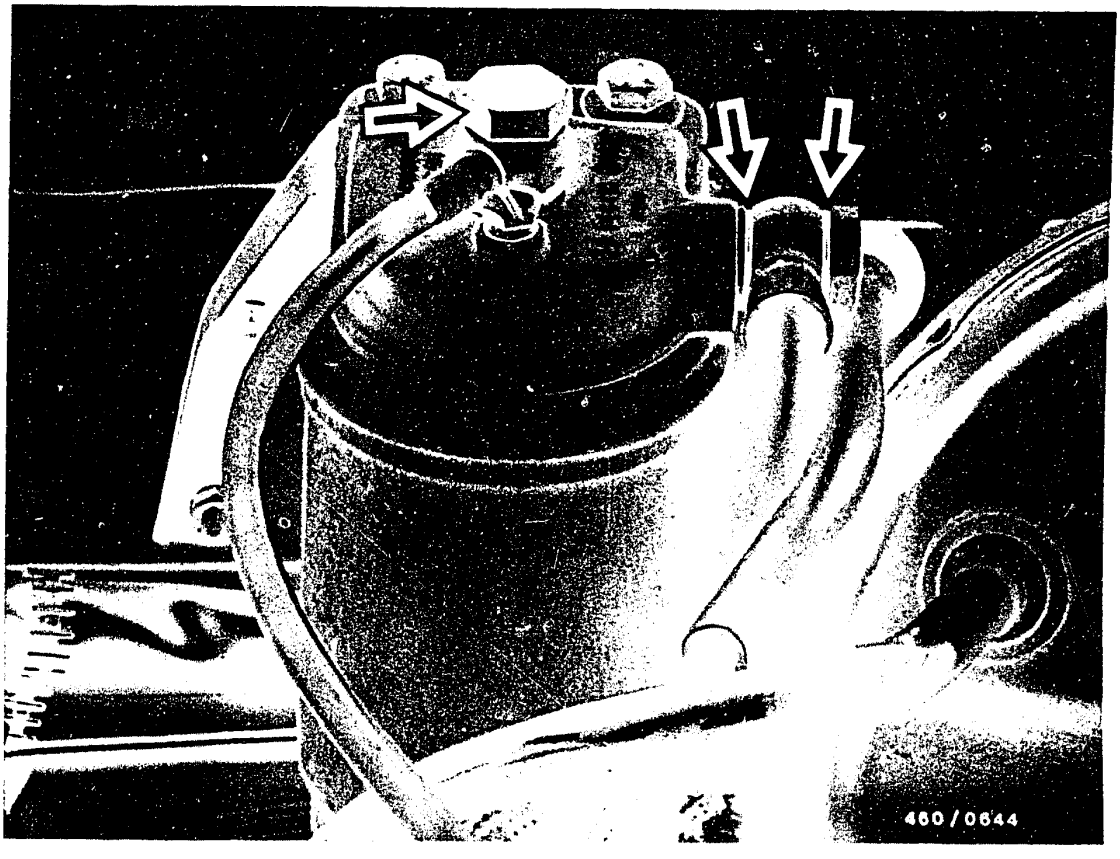
15. Checking injection system for tightness

Check for tightness with engine warm.

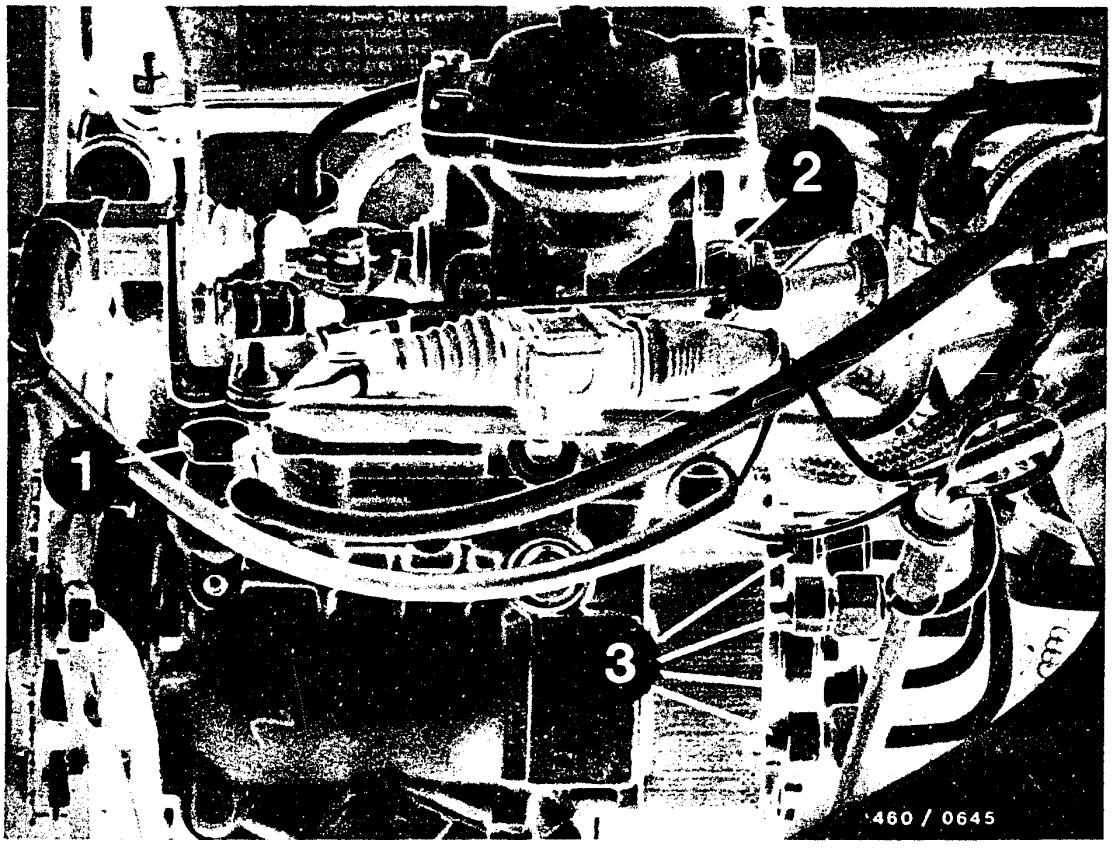
Check all fuel line connections.

Pay special attention to:

- Connections on nozzle holders (A - D)

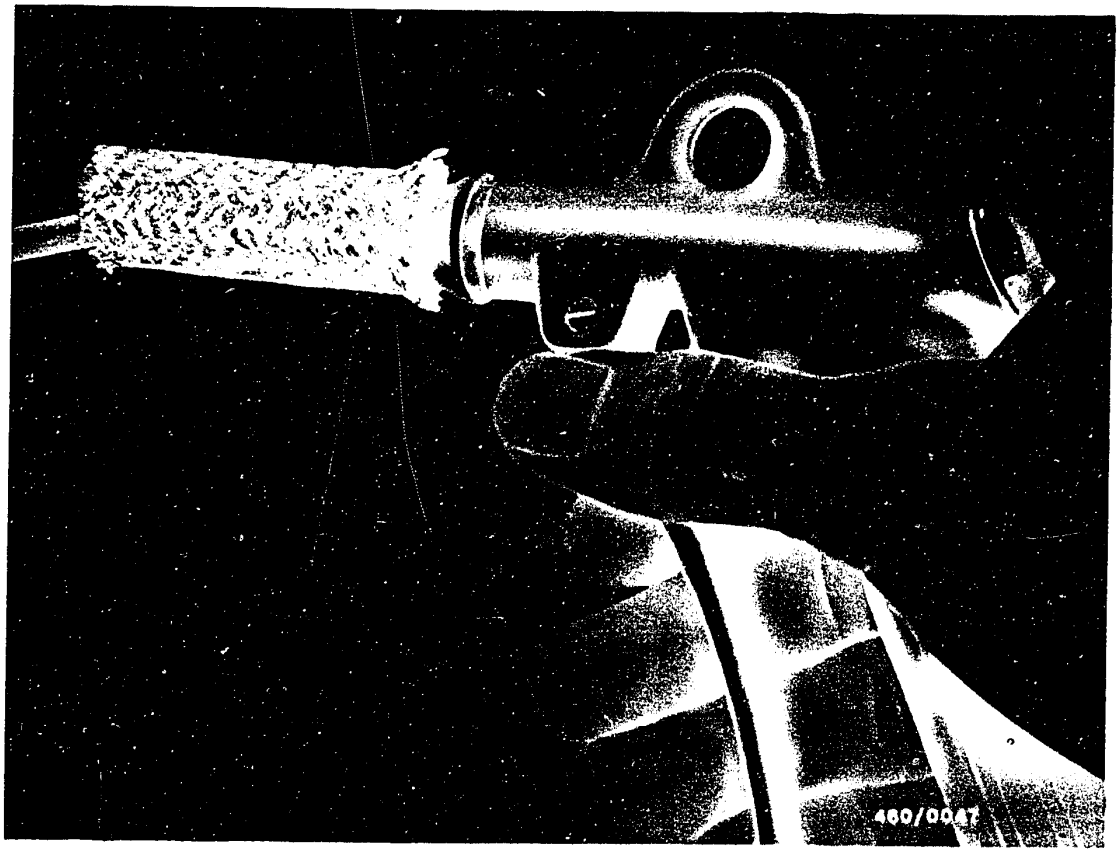


- Fuel filter connections (arrows)



- Inlet line (1) and return line (2) on distributor-type injection pump
- Delivery valve holders (3) on distributor head

Inspect fuel lines for hairline cracks.



16. Checking fuel lines

Visually inspect suspect fuel lines.

If no pinches or kinks are found, the fuel line in question must be removed.

Check fuel line for clogs by blowing out with compressed air; clean if necessary.

A suitable piece of hose can be used to direct compressed air through line.

17. Measurement of exhaust emissions - air filter check

17.1 Measurement of exhaust emissions

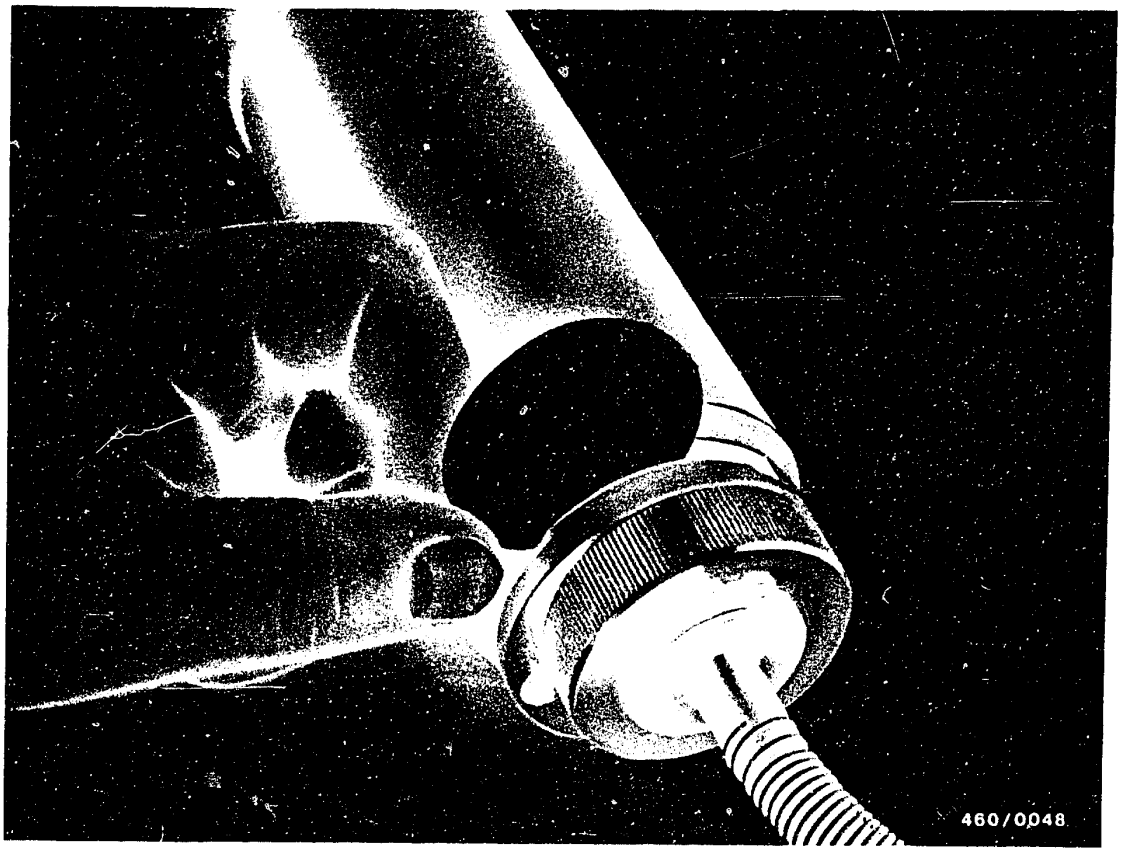
Summary of legal regulations (as of April 1978):

These regulations apply only to new vehicles with at least 4 wheels and a maximum permissible speed of over 25 km/h.

Exhaust emission measurements are not a required part of major vehicle inspections.

Components which could have an effect on environmental pollution must be designed such that prescribed emission limits are not exceeded under conditions of vehicle operation, regardless of vehicle vibrations.

These regulations apply in particular to cold-start systems and full-load stops.
Vehicle approval is granted solely by the Rhineland Westphalian branch of the Technical Supervisory Authority (TUEV) in Essen.



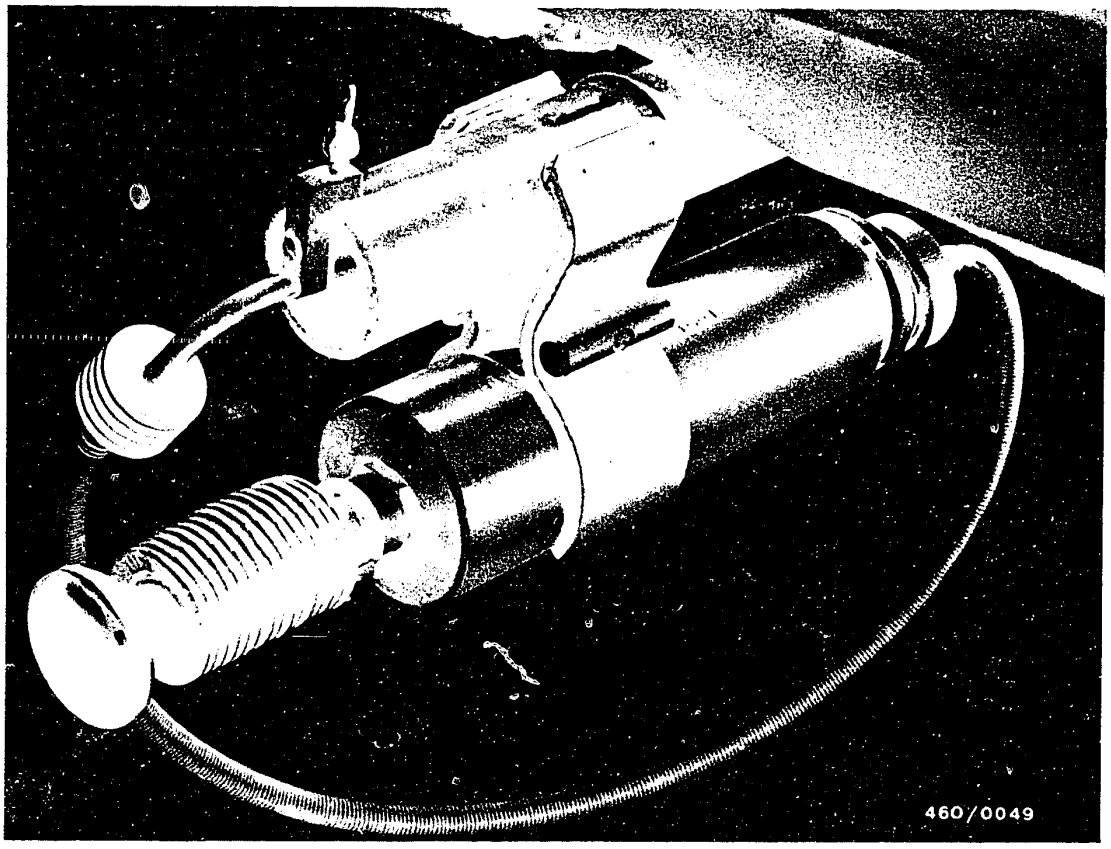
17.1.1 Test set-up

Exhaust gas emissions are measured using the BOSCH exhaust gas tester.

The exhaust gas tester consists of the following units:

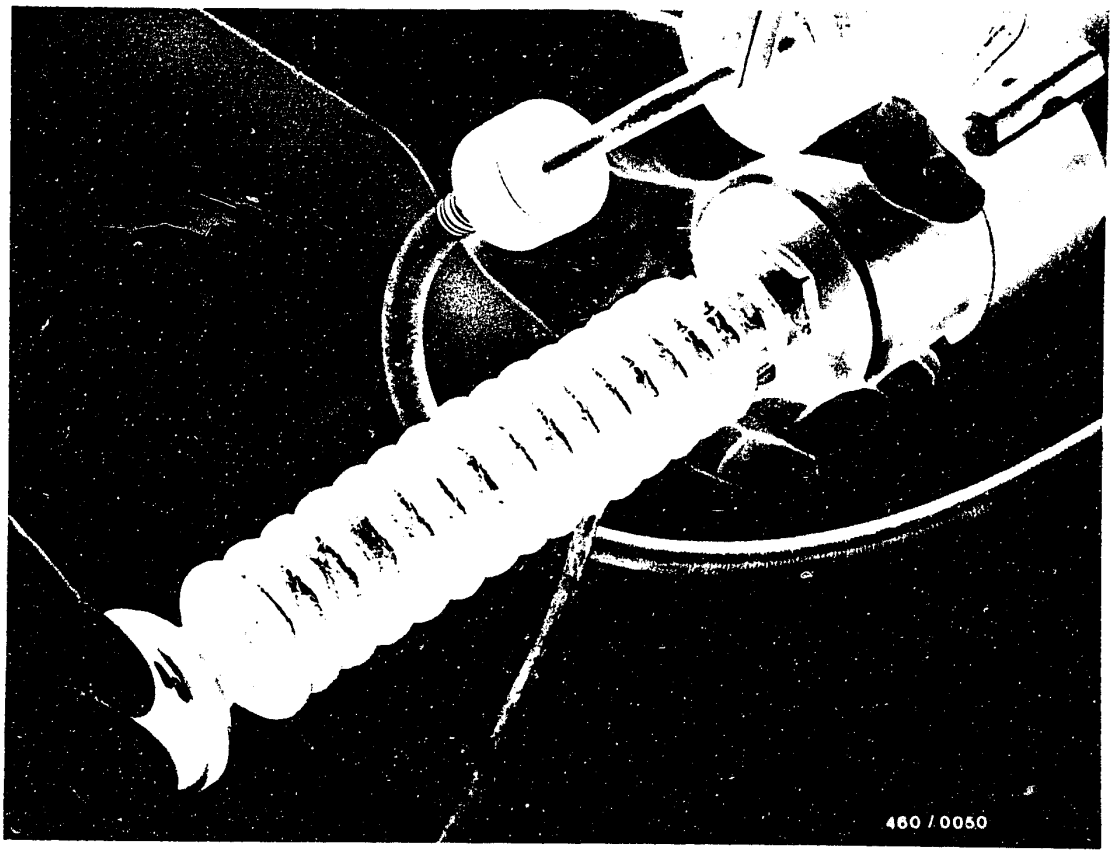
- Accessory box with dosing pump 0 681 169 038
- Evaluation unit 0 681 169 039

Insert filter disc into dosing pump.



Clamp dosing pump to exhaust pipe with appropriate clamp.

Place sampling probe as far into exhaust pipe as possible and clamp in position.



17.1.2 Test procedure

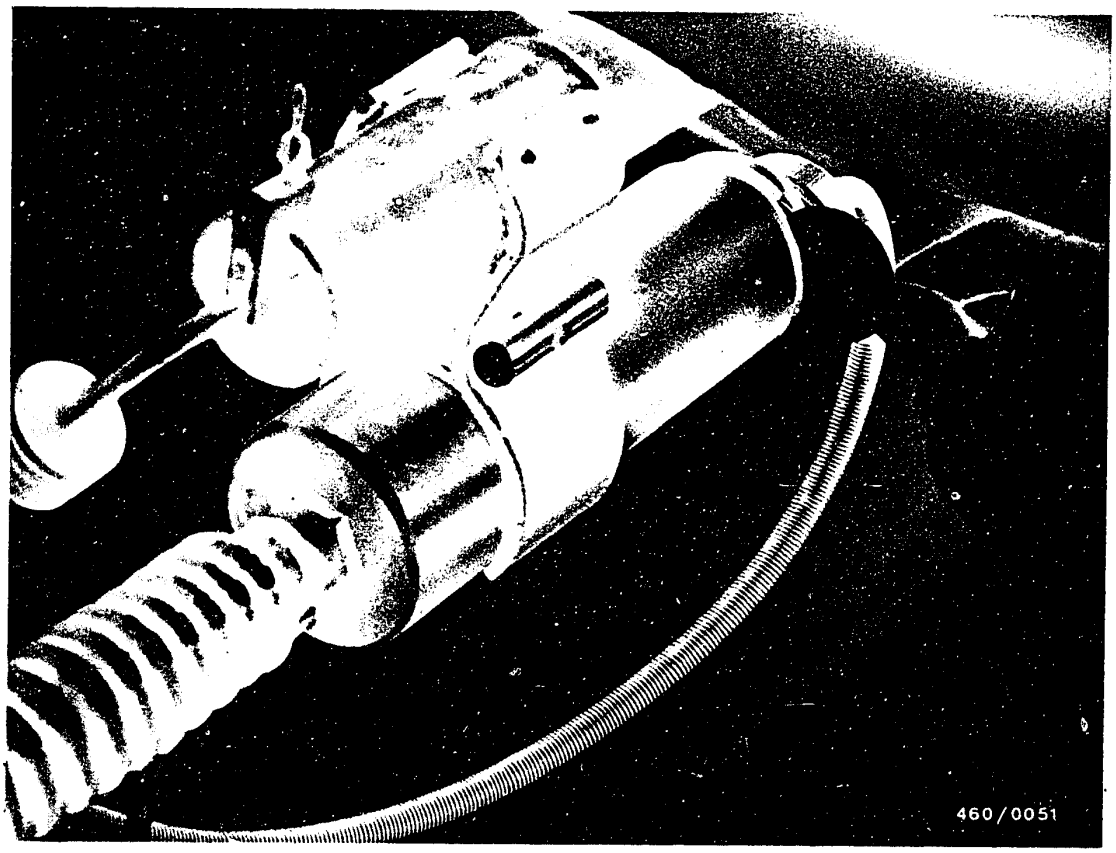
Cock dosing pump by pushing black knob in.

Take rubber ball on trigger tube with you into cabin.

The test may be performed on the power absorbtion roller (chassis dynamometer) or on the road (upgrade). If at all possible, the test should be performed on the chassis dynamometer.

Find the gear which will produce a vehicle speed of approx. 40 km/h with the accelerator fully depressed.

Load the engine such that the speed drops to approx. 25 km/h with the pedal in the same position.



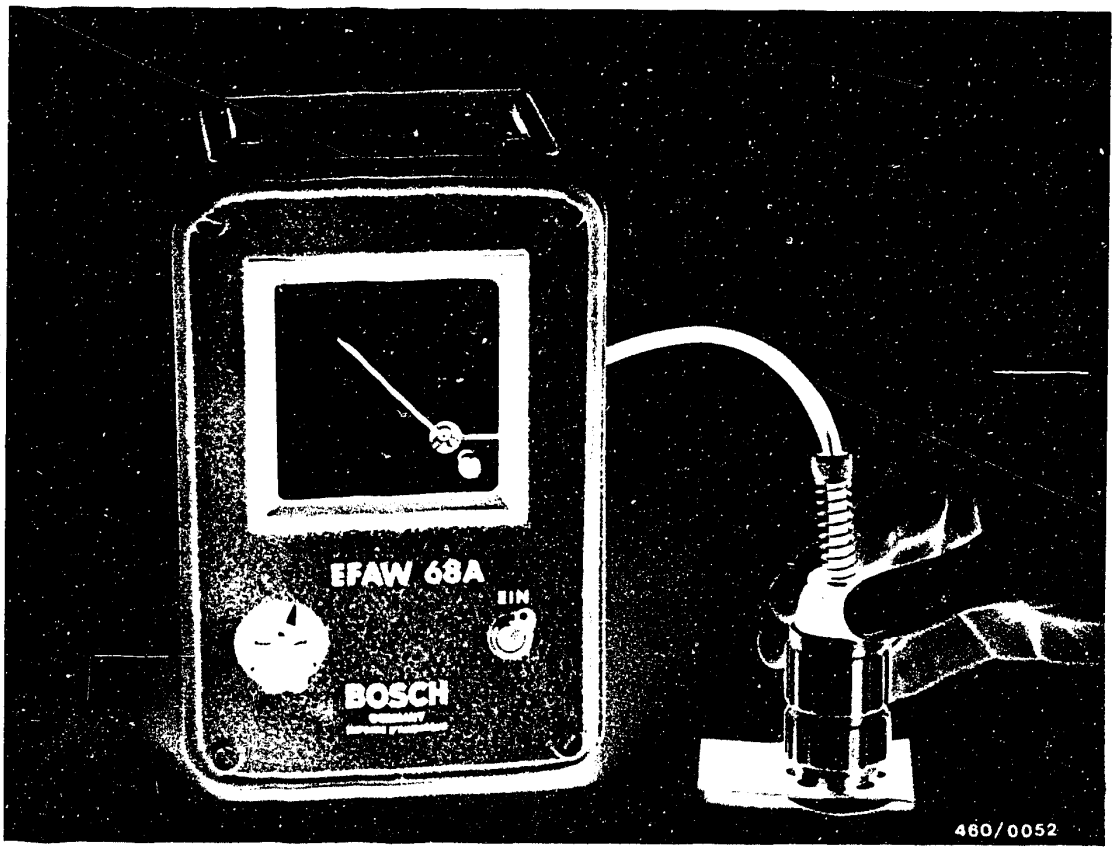
Maintain this load condition for 5 seconds, then trigger dosing pump by squeezing rubber ball.

Shut off engine.

C a u t i o n !

Take appropriate care when performing the following step, as running engine has heated exhaust pipe.

Remove filter disc from dosing pump.



Place calibration disc on approx. 10 clean filter discs. Place photocell of evaluation unit on calibration disc. Switch on unit and set opacity reading to 5.0.

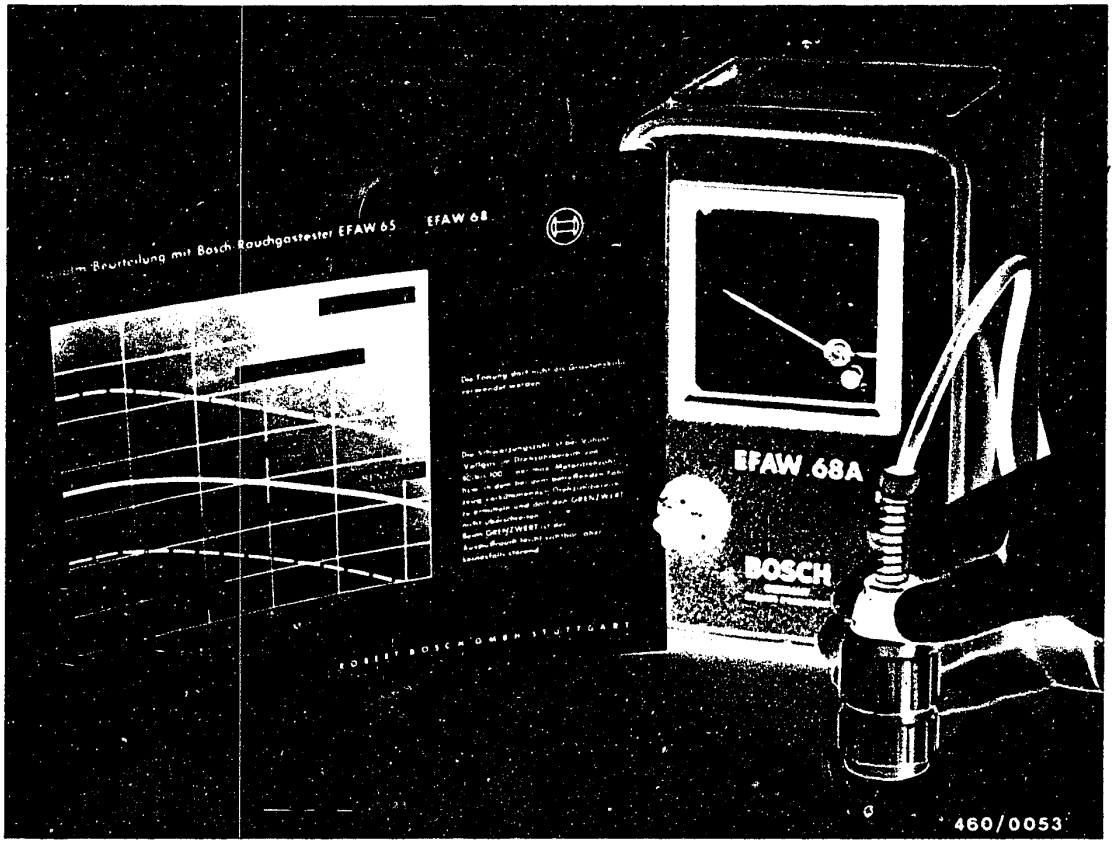
Remove calibration disc and place photocell on clean filter disc.
The unit must indicate an opacity of 0.0.

Replace battery if necessary.

With unit off, pointer must indicate an opacity of 10.0, otherwise unit is defective.

Place filter disc from dosing unit sooty side up on the clean filter discs.

Place photocell on this filter disc and read smoke factor on meter scale.



Check smoke factor against evaluation sheet.

Note kW (HP DIN) specification of manufacturer.

17.2 Checking air filter

Remove and visually inspect air filter.

Air filter evaluation criteria:

- Dusty air filter
 (check by tapping filter)
- Oily air filter
- Solid objects such as leaves in air filter

Replace filter element if necessary.



18. Idle speed adjustment

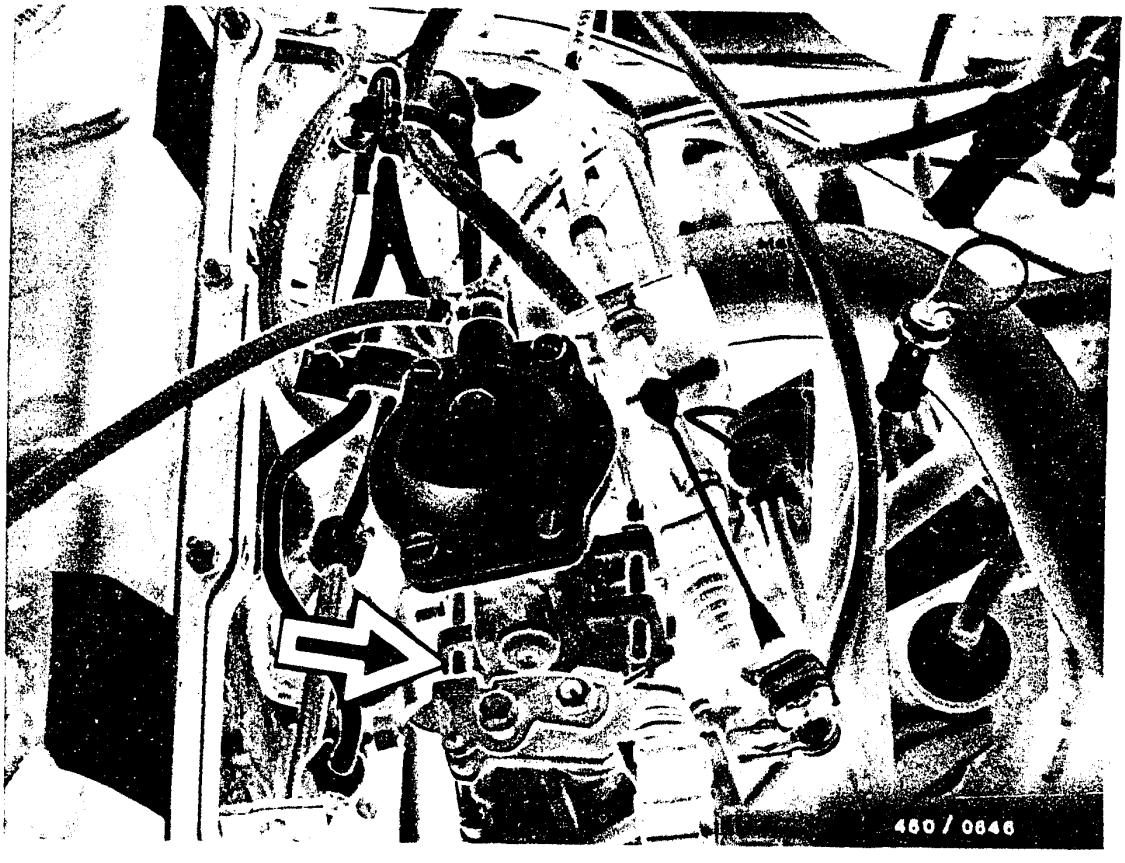
Connect tachometer (photoelectric, for example) to engine.

Start engine and allow to run at idle (arrow in photo above shows adjustment screw on diesel engine).

Note:

Idle speed must be set with engine at operating temperature.
Coolant temperature should be approx. 80°C.

Note that camshaft and injection pump are driven at half the engine speed.

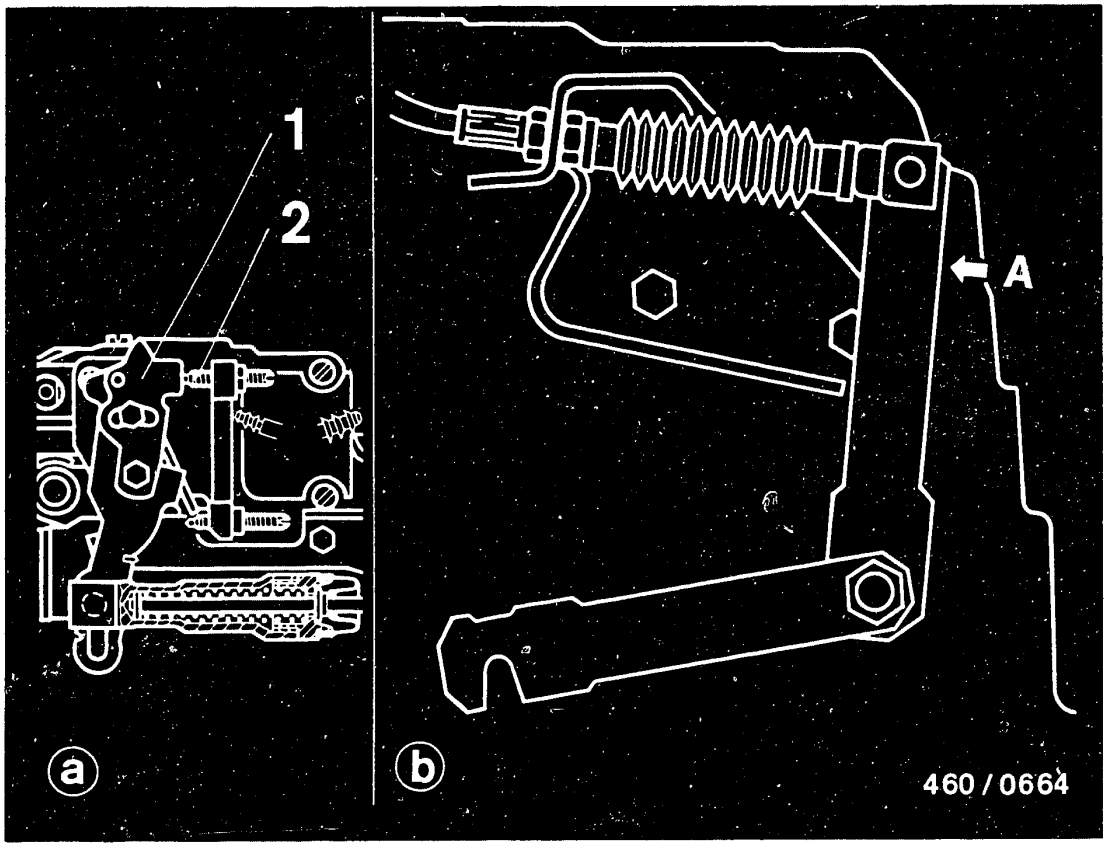


Idle speeds:

1.5 and 1.6 l diesel to 9/82 (except Audi 80 D)	825 ±25 min^{-1}
1.6 l Turbo-diesel	950 ±30 min^{-1}
Vehicles with automatic transmission: (arrow in photo shows adjustment screw)	930 ±30 min^{-1}

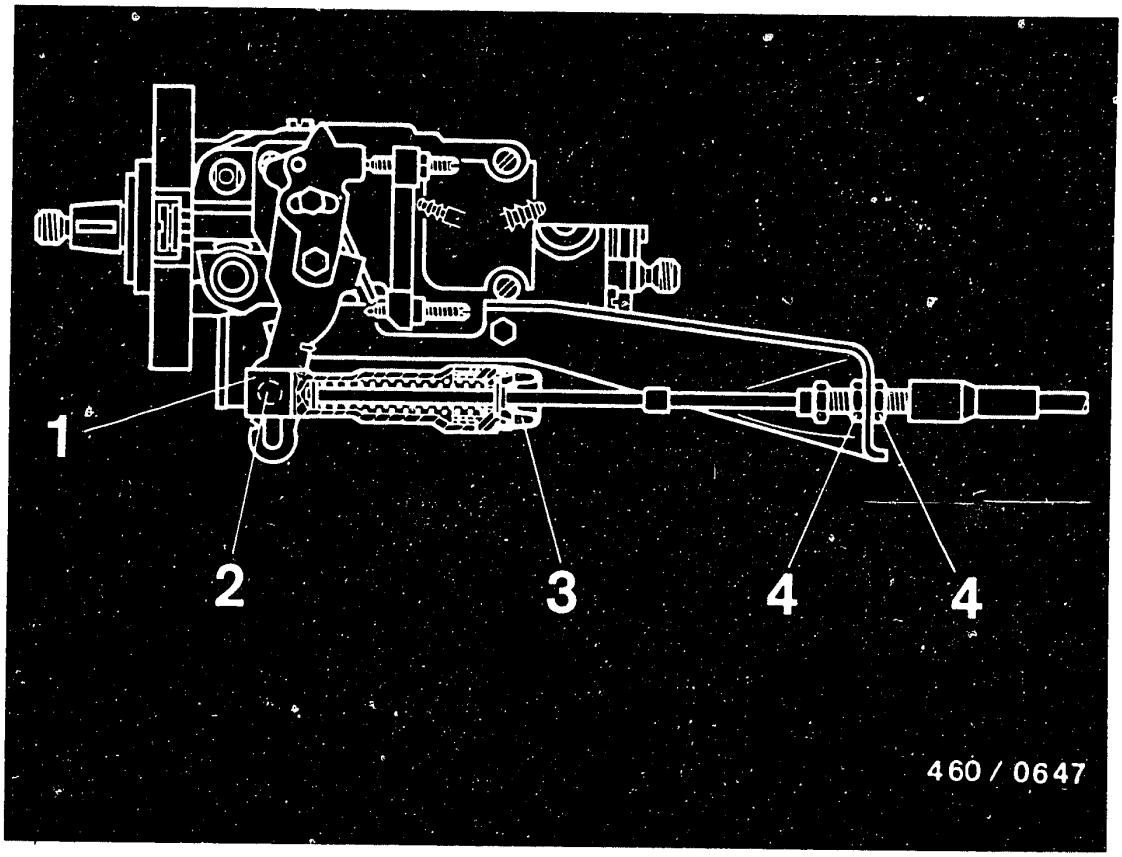
After adjusting idle speed, tighten lock nut against adjustment screw and seal.

Note:
Before performing any work on vehicles with automatic transmissions with the engine running, place shift lever in "Park" and apply hand brake.



18.1 Adjusting accelerator pedal cable in vehicles with automatic transmission

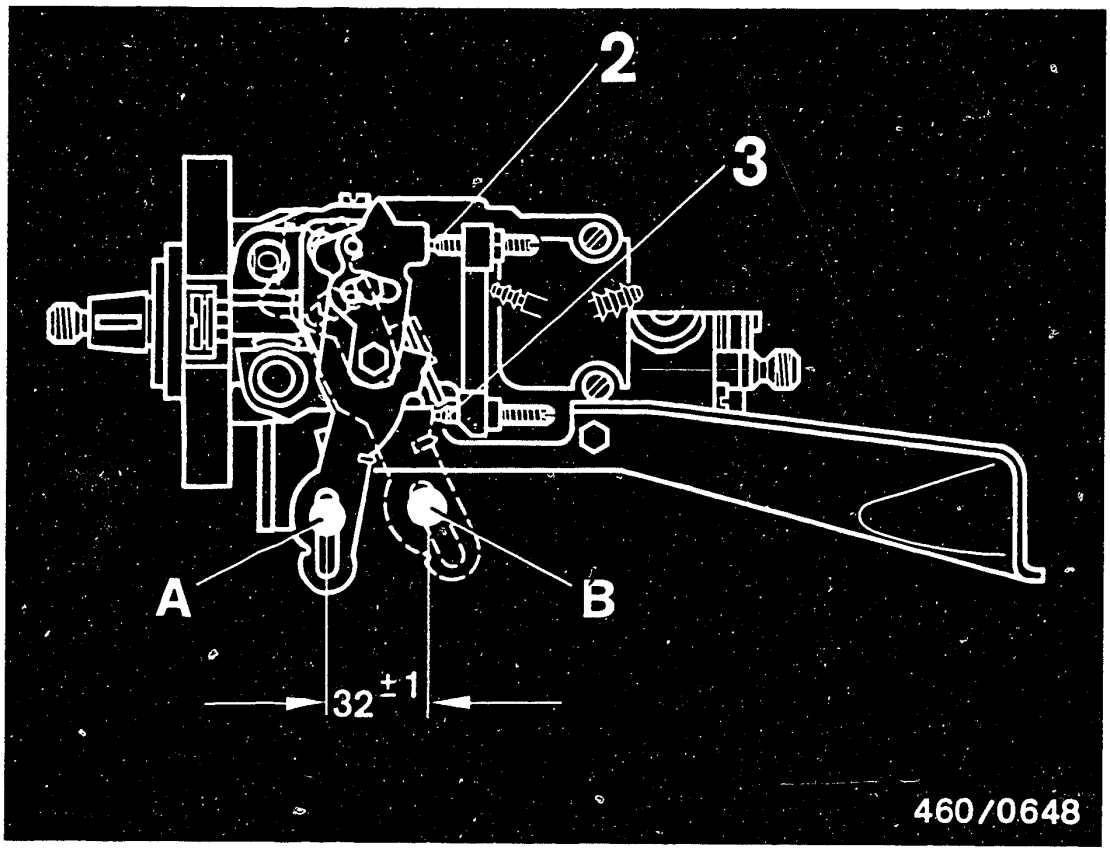
Adjust accelerator pedal cable so that speed control lever (1) of injection pump rests against idle stop (2) (Fig. a) and fulcrum lever on transmission (A) is in zero-throttle position (Fig. b).
If these adjustments are made incorrectly, up-shifting will occur too late in the middle speed range, and the transmission will not be decoupled in the "E" range.



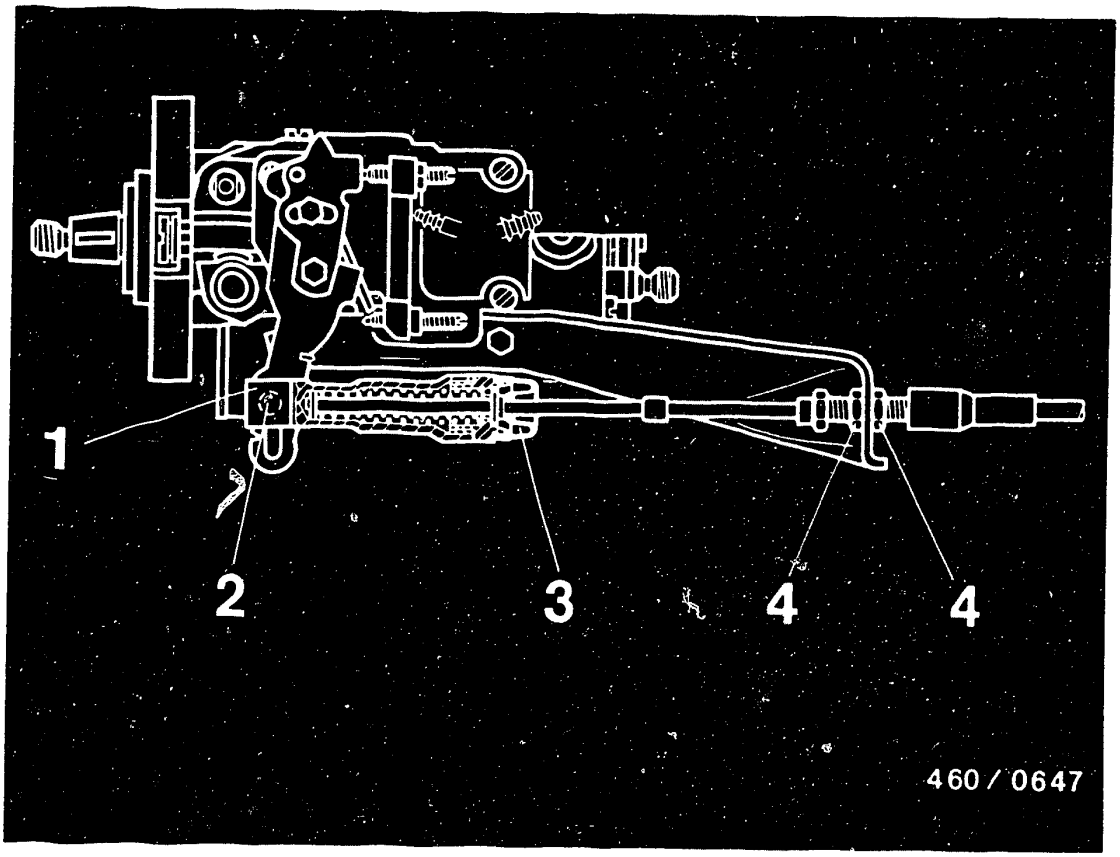
1 = Clip
2 = Ball socket
3 = Rubber boot
4 = Lock nuts

Adjustment procedure:

Loosen bowden cable adjustment nut on accelerator pedal and unhook cable.
Remove clip (1) and ball socket (2) from speed control lever.

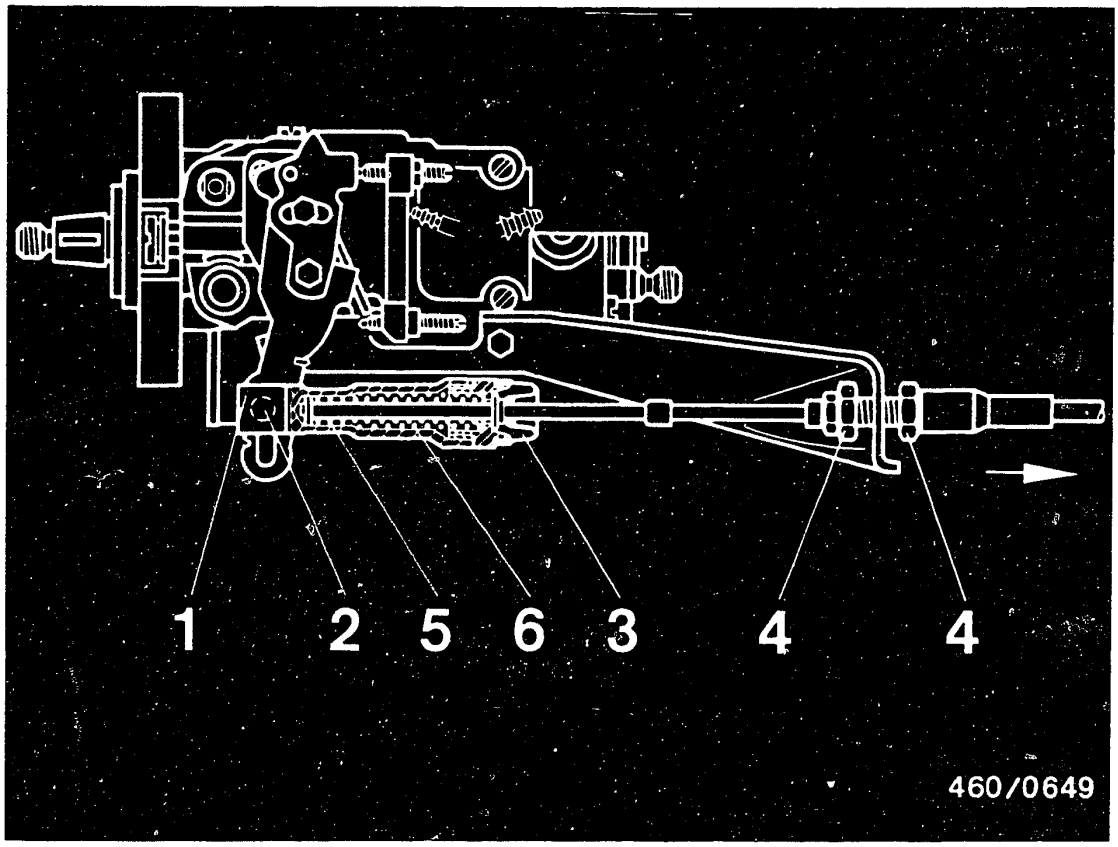


Set travel of ball head between idle stop (2) and full-load stop (3) to 32 ±1 mm by sliding ball head in slot of speed control lever.
Replace ball socket and secure with clip.



1 = Clip
2 = Ball socket
3 = Rubber boot
4 = Lock nuts

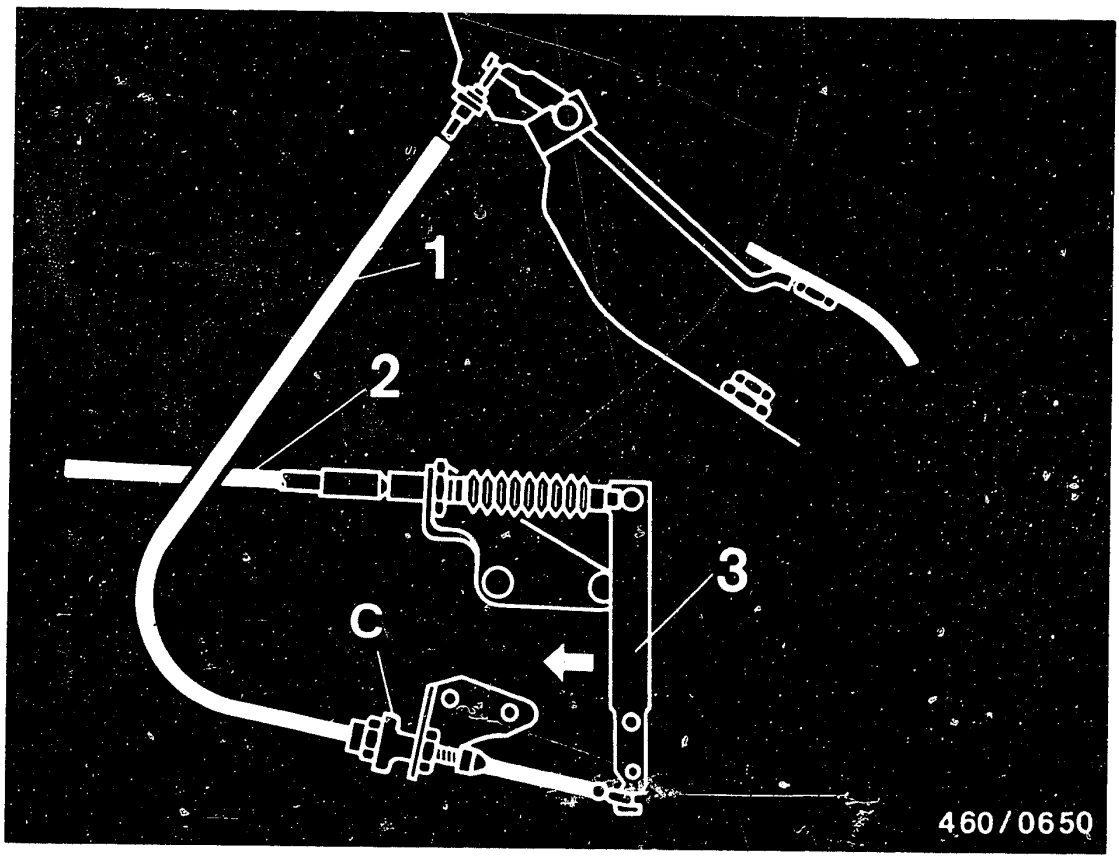
Remove rubber boot (3) and loosen lock nuts (4) on pump bracket.



1 = Clip
2 = Ball socket
3 = Rubber boot
4 = Lock nuts
5 = No-load spring
6 = Overtravel spring

Push fulcrum lever on transmission in zero-throttle direction while pulling control cable sheath in the direction of the arrow; no-load spring must not be tensioned.
Tighten lock nuts in this position against bracket.

Replace accelerator pedal cable.

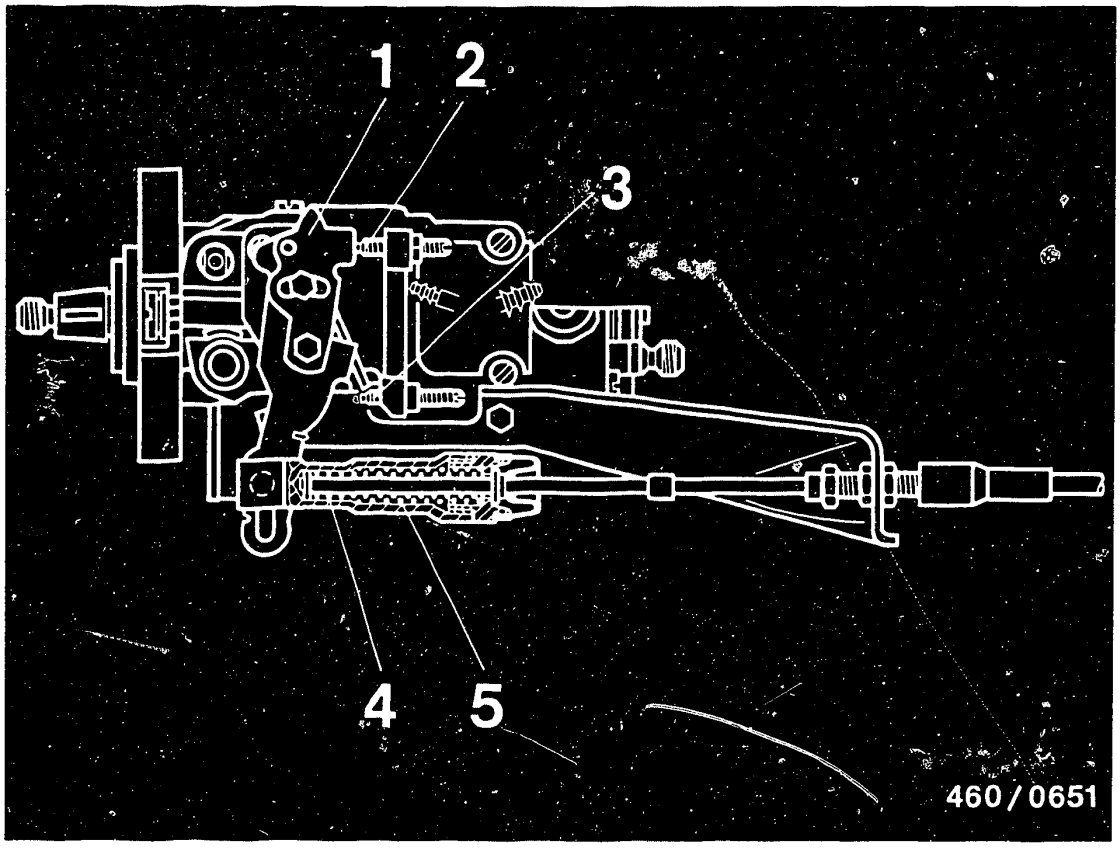


1 = Accelerator pedal cable
2 = Bowden cable to injection pump
3 = Fulcrum lever on transmission

Push accelerator pedal all the way in until it stops (kick-down position).
A second person must now unscrew adjusting nut "C" until fulcrum lever on transmission rests against stop in direction of arrow.
Overtravel spring must be compressed.

Tighten lock nut against adjusting nut on accelerator pedal.

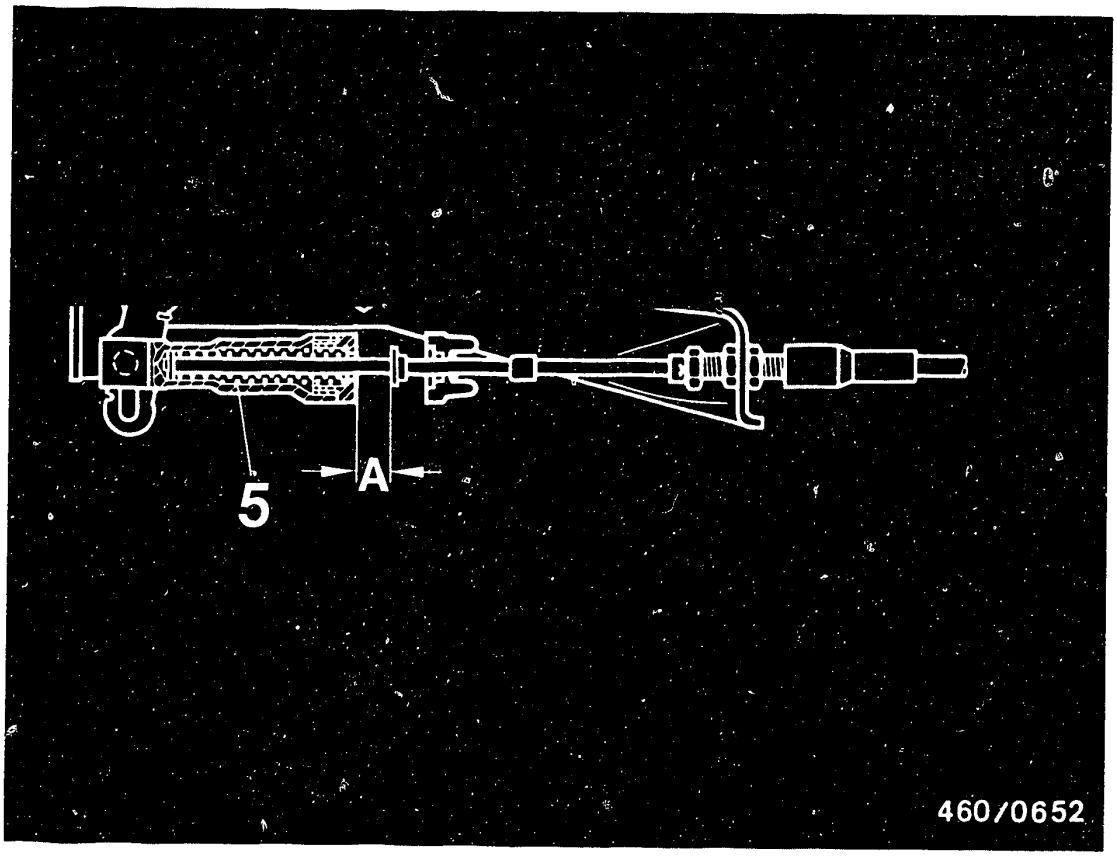
Accelerator pedal cable must not be preloaded.



Check adjustment

- Speed control lever (1) against idle stop (2); no-load spring (4) must not be tensioned, and fulcrum lever on transmission must be in zero-throttle position.

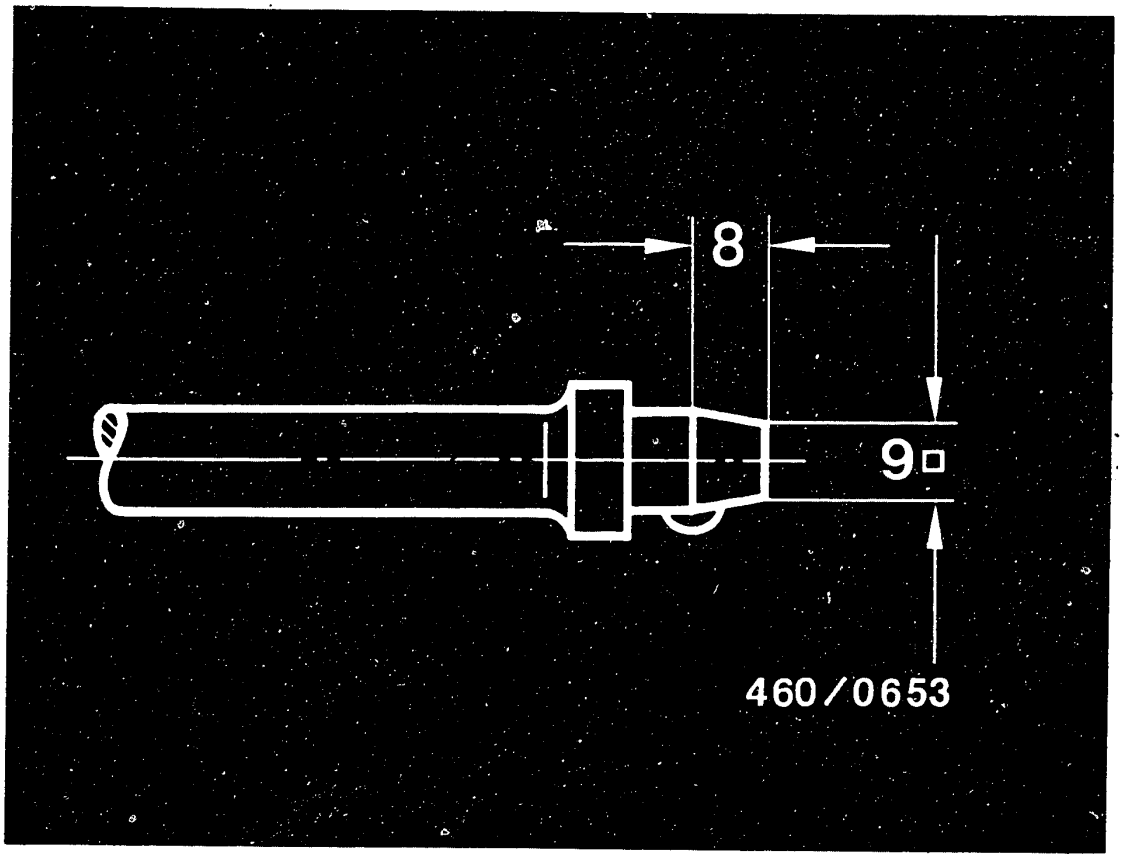
- Push accelerator pedal to full-load point. Speed control lever must rest against full-load stop (3) (overtravel spring (5) must not be compressed, i.e. no kickdown.)



5 = Overtravel spring

Push accelerator pedal past full-load point to stop. Fulcrum lever on transmission must rest against stop.

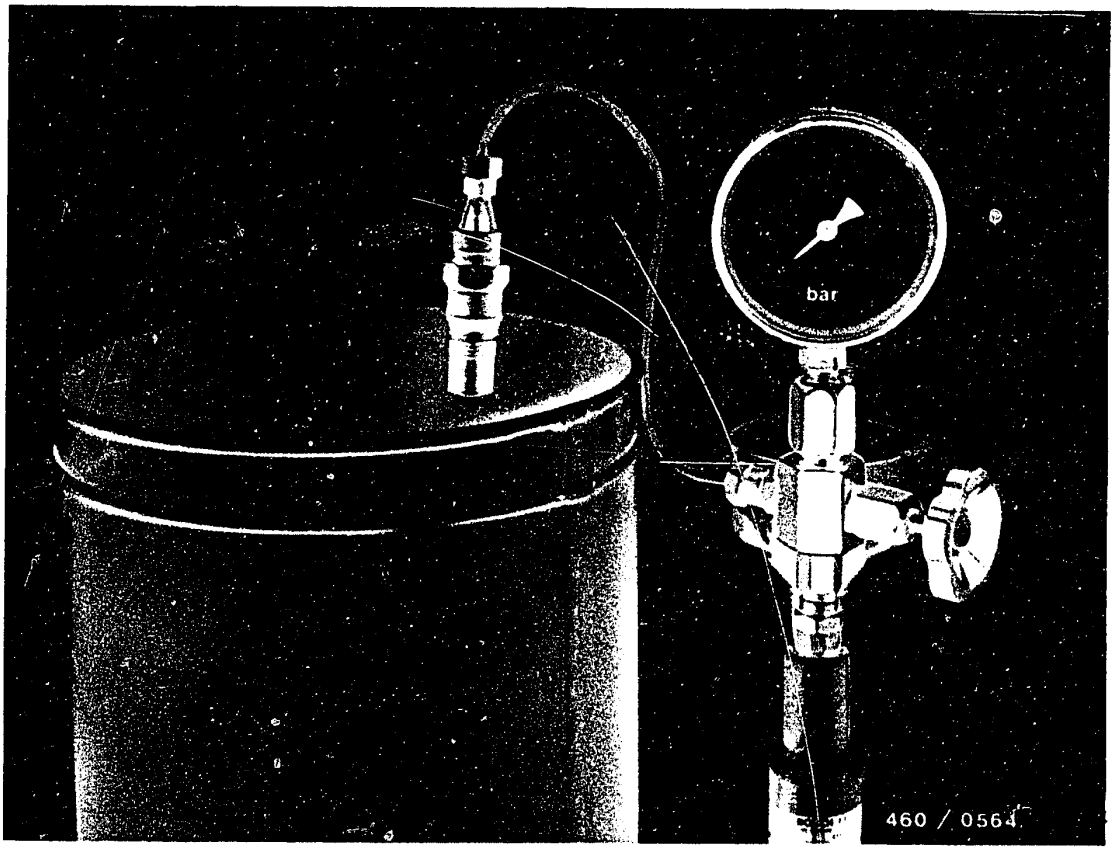
Overtravel spring (5) must be compressed (shown above by travel "A").



19. Testing injection nozzles

Remove injection nozzles (turbocharged engine).

The manifold pressure compensator makes the injection nozzle of No. 2 cylinder in turbocharged engines difficult to reach. To remove the nozzle with a 27 mm socket, rework the square end of a 1/2" drive socket wrench extension as shown above.

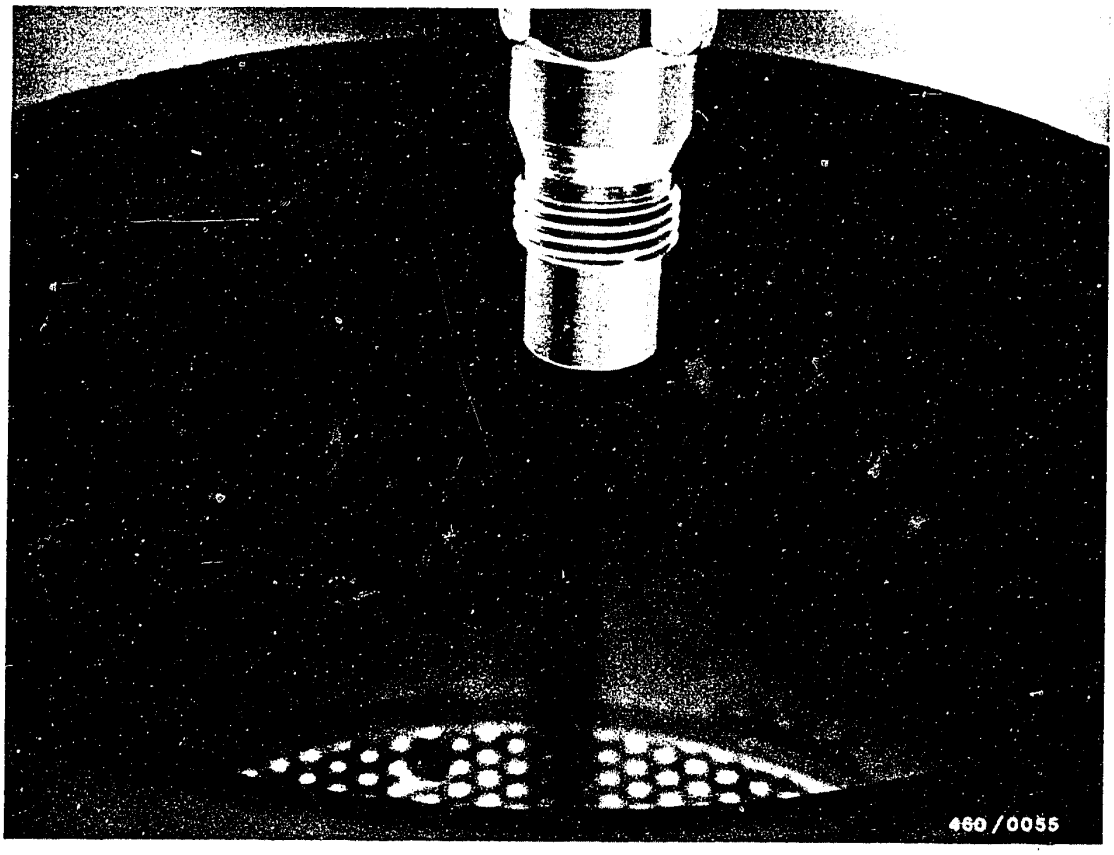


Test nozzles with nozzle tester EFEP 60 H 0 681 200 502.

Attach nozzle with holder to nozzle tester.

Caution!

Keep hands away from fuel spray. The high-pressure fuel will penetrate the skin and can cause blood poisoning.



19.1 Checking spray pattern

Switch off pressure gauge.

The spray pattern can be checked only when the lever is operated rapidly (approx. 4 ... 6 strokes per second).

The spray pattern must be compact and well defined.

19.2 Chatter test

With the pressure gauge switched off, operate tester lever slowly through its entire stroke (1 ... 2 strokes per second).
Good injection nozzles should chatter as fuel is released.

19.3 Checking spray pressure

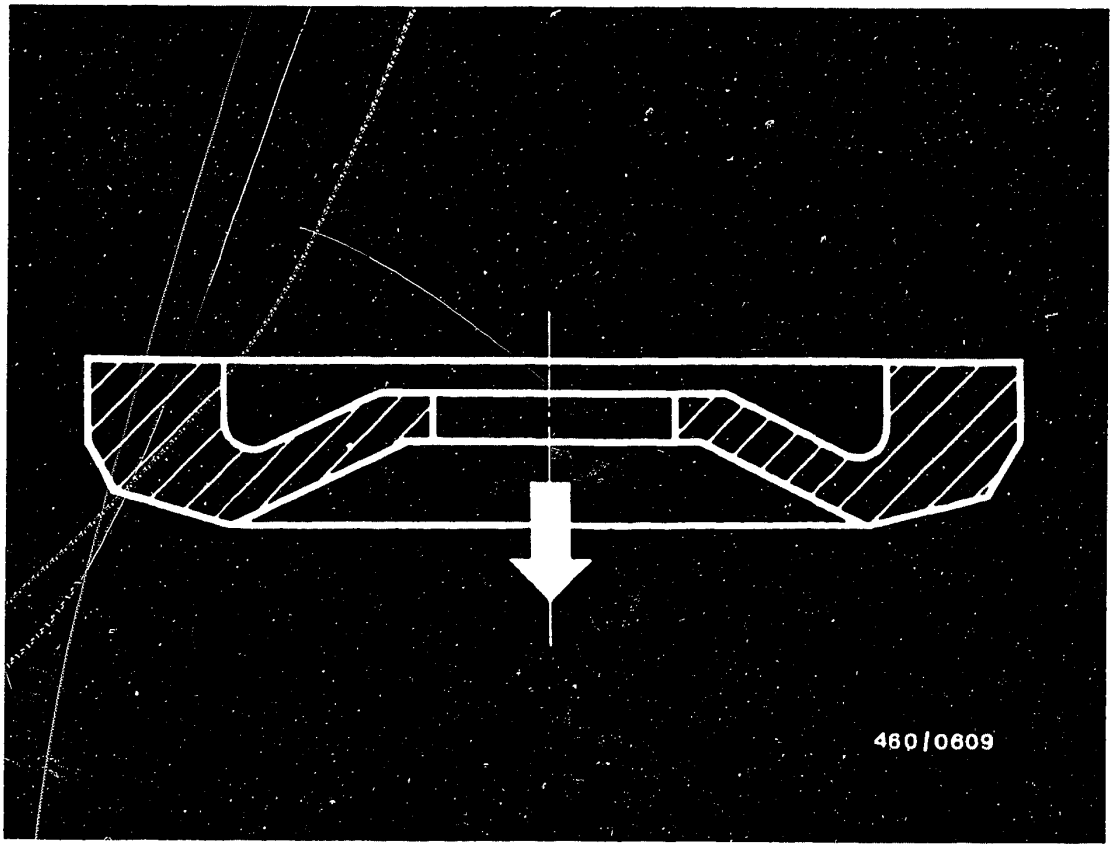
Switch on pressure gauge.
Push lever slowly downward.
Note pressure on gauge when nozzle begins to spray.
If not the same as the set value, opening pressure must be corrected with shims behind spring in nozzle holder.

Set value, diesel engine:	130 +8 bar
Set value, turbocharged engine:	155 +8 bar
Thicker shims:	higher opening pressure
Thinner shims:	lower opening pressure

Increasing spring travel by 0.05 mm increases opening pressure by 5.0 bar.

19.4 Leaktightness test

Switch on pressure gauge.
Push lever slowly downward and hold pressure at approx. 20 bar below opening pressure for 10 seconds. Nozzle should not drip.

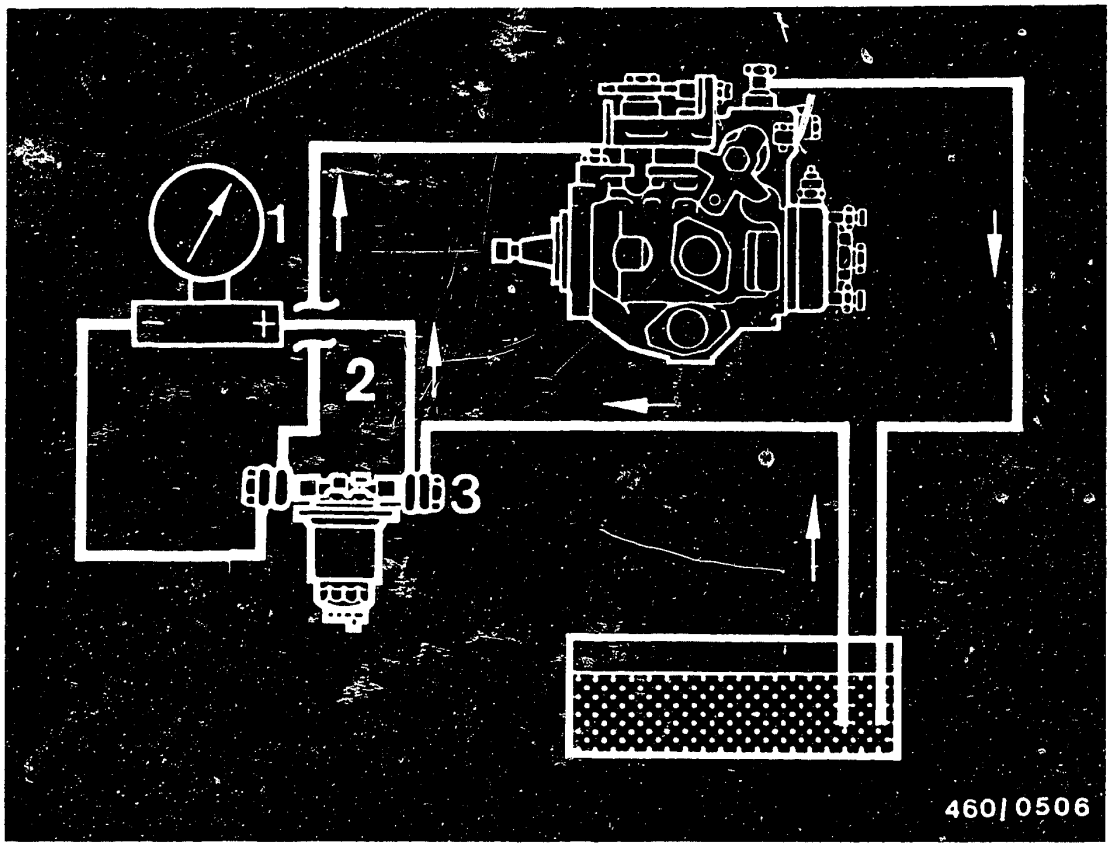


19.5 Installing injection nozzles

Use new heat shields when reinstalling injection nozzles. Install heat shield in orientation shown in drawing above; arrow points toward cylinder head.

Tighten nozzle holder mounting screws to 70 Nm.

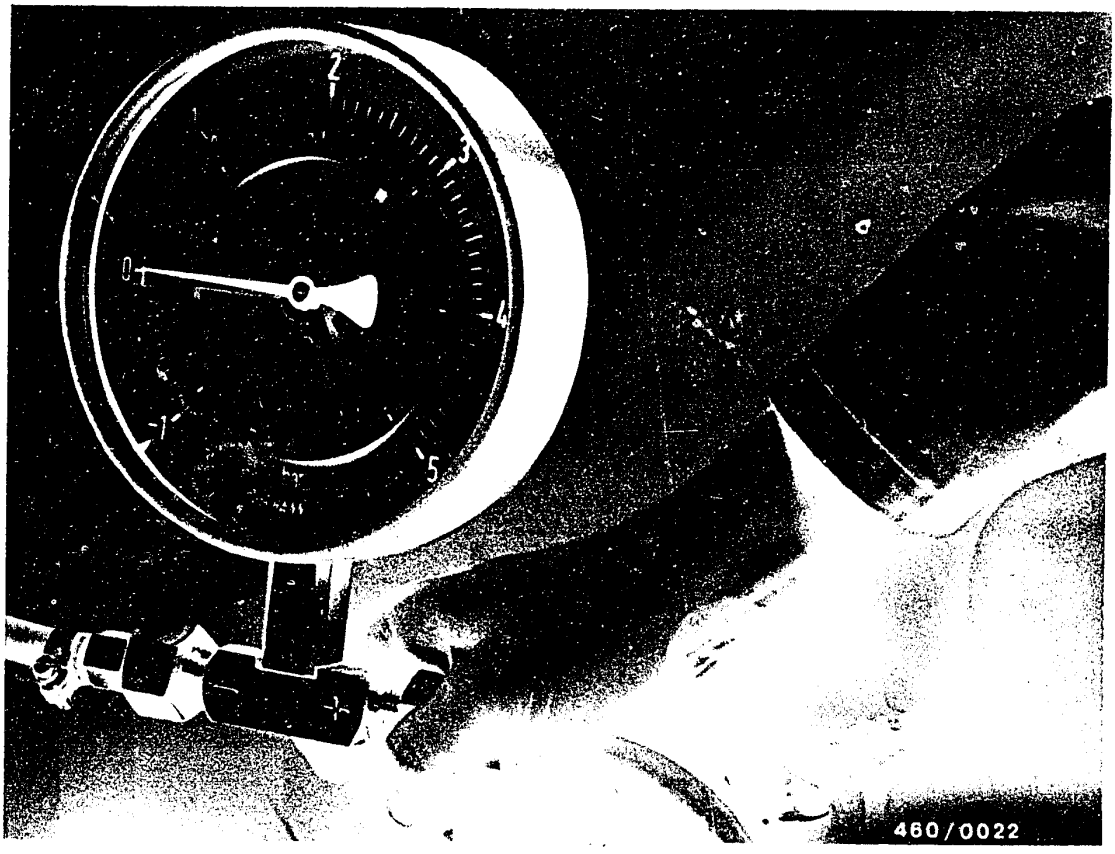
Tighten union nuts of delivery lines to 25 Nm.



1 = Differential pressure gauge
2 = Filter discharge
(use inlet union and extra-long hollow bolt, 2 443 456 020)
3 = Filter inlet
(use inlet union and extra-long hollow bolt, 2 443 456 020)

20. Testing fuel filter

Connect differential pressure gauge to fuel filter at corresponding fittings.

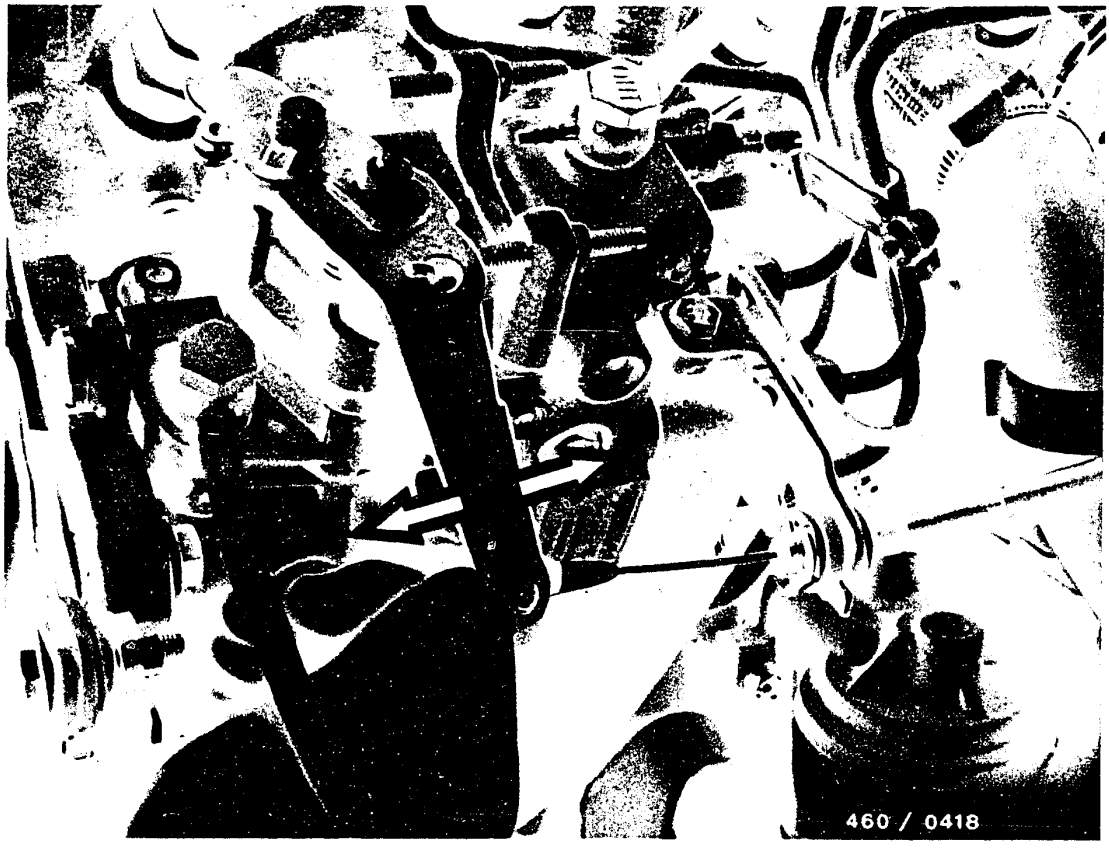


Connect (+) side of differential pressure gauge to fuel filter inlet.

Connect (-) side of pressure gauge to filter discharge.

Observe connection diagram.

Allow engine to run until all air has escaped from fuel system.



Operate injection pump control lever briskly (1 second) from idle stop to maximum speed stop.

Release control lever and read off differential pressure on pressure gauge.

Differential pressure must not exceed 0.3 bar. If pressure is greater, replace filter.

Remove test connections.

Bleed fuel system if necessary.

21. Testing pre-heating system

21.1 Test instruments required

Pre-heating system tester	e.g. ETT 011.00	0 684 101 100

21.2 Workshop recommendations

21.2.1 We recommend that R-type sheathed-element glow plugs be replaced every 45,000 km.

21.2.2 Pre-heating time

Pre-heating time varies with ambient temperature.

Testing pre-heating system

Note:

All engines are equipped with a quick-heating system.
o Test requirement: battery must be good.

Checking voltage supply

- Hook up test lamp between cylinder 4 glow plug and ground.
- Remove wire from engine temperature sensor.
- Turn ignition key to pre-heating position for a maximum of 15 seconds. Test lamp must light.
- Reattach wire to engine temperature sensor.

Does test lamp light?

yes

Test glow plugs either with a test lamp or pre-heating system tester ETT 011.00.

1. Checking glow plug voltage with test lamp:

- Remove glow plug supply cable and bus bar.
- Connect one side of test lamp to positive battery terminal and other side to each glow plug in turn.
- If lamp lights, glow plug is good.
- If lamp does not light, glow plug is defective. Replace plug (tighten to 40 Nm).
 See note if burned heating elements found.

2. Checking current consumption of glow plugs using tester ETT 011.00:

- Place ammeter (e.g. ETT 011.00) in supply line to glow plugs
- Remove wire to engine temperature sensor.
- Turn ignition key to pre-heating position for a maximum of 15 seconds.
- Read current consumption.

 Set value: 48 A

Is amperage correct?

no

Note:

After stabilization, current consumption is approx. 12 A per glow plug. Correlation of approximate current consumption to the number of defective plugs:
36 A = one plug defective
24 A = two plugs defective
12 A = three plugs defective
0 A = all plugs defective

These values apply only if battery voltage is more than 11.5 V.

yes

Glow plugs are good (problem is in fuel supply to plugs)

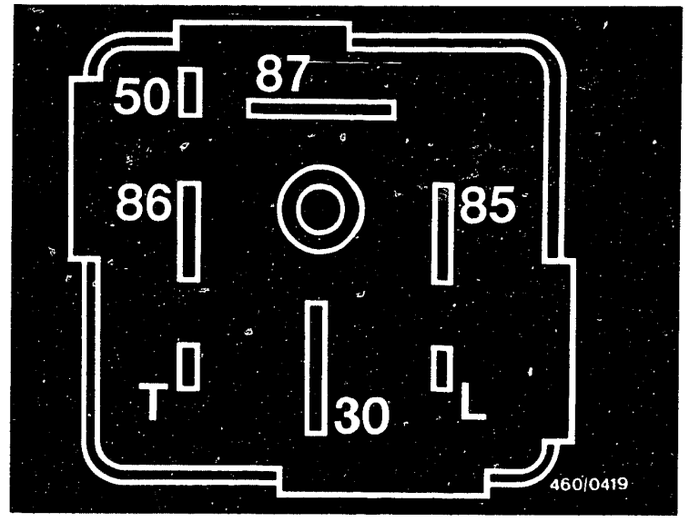
no

Continued on pages D7/D8

Note:

If the engine is hard to start, also check the automatic post-heating and heating functions during starting.

1. After pre-heating, the duration of which is a function of temperature (pilot light goes out), voltage must be present at the glow plugs for 6 or 7 more seconds. Do not operate the starter during this test. If no voltage is present at the glow plugs, replace the pre-heating control relay.
2. During starting (with starter switched on) voltage must be present at the glow plugs. If no voltage is present, check wire between terminal 50 of the pre-heating control relay and the starter. If good, replace relay.



Checking pre-heating control

Testing LED

- Disconnect pre-heating control relay. Ground terminal "L" in relay socket using test lead.
- Turn on ignition.

Does pre-heating pilot lamp light?

no → LED defective -- replace.

Check continuity between relay terminal L and LED

yes ↓

Pre-heating control relay and/or engine temperature sensor are defective. Check relay operation. (See note above.)

- Disconnect glow plug supply cable
- Disconnect wire at engine temperature sensor and let hang freely.
- Turn on ignition. Pilot lamp must light for approx. 25 ... 30 s.
- Ground engine temperature sensor wire -- pilot lamp must go out.

Does LED light?

no → Replace pre-heating control relay.

yes ↓

Replace engine temperature sensor.

Testing pre-heating system (cont'd.)

Glow plug fuse defective

- Check glow plug fuse.

Does test lamp light?

no → Replace defective fuse.

yes ↓

Voltage not present at terminal 30 of glow plug relay

- Clip test lamp to terminal 30 of relay

Does test lamp light?

no → **Possible causes:**

- Open circuit between terminal 30 and battery
- Defective cable -- replace.

yes ↓

Glow plug relay does not attract

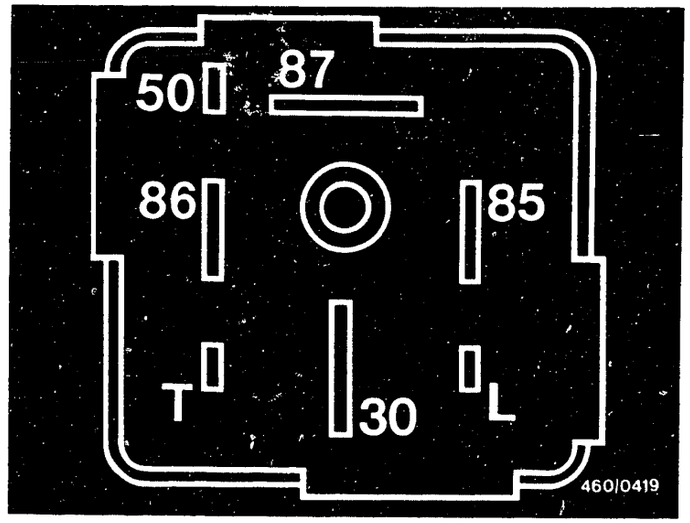
- Connect test lamp to relay terminal 86
- Turn ignition key to pre-heating position.

Does test lamp light?

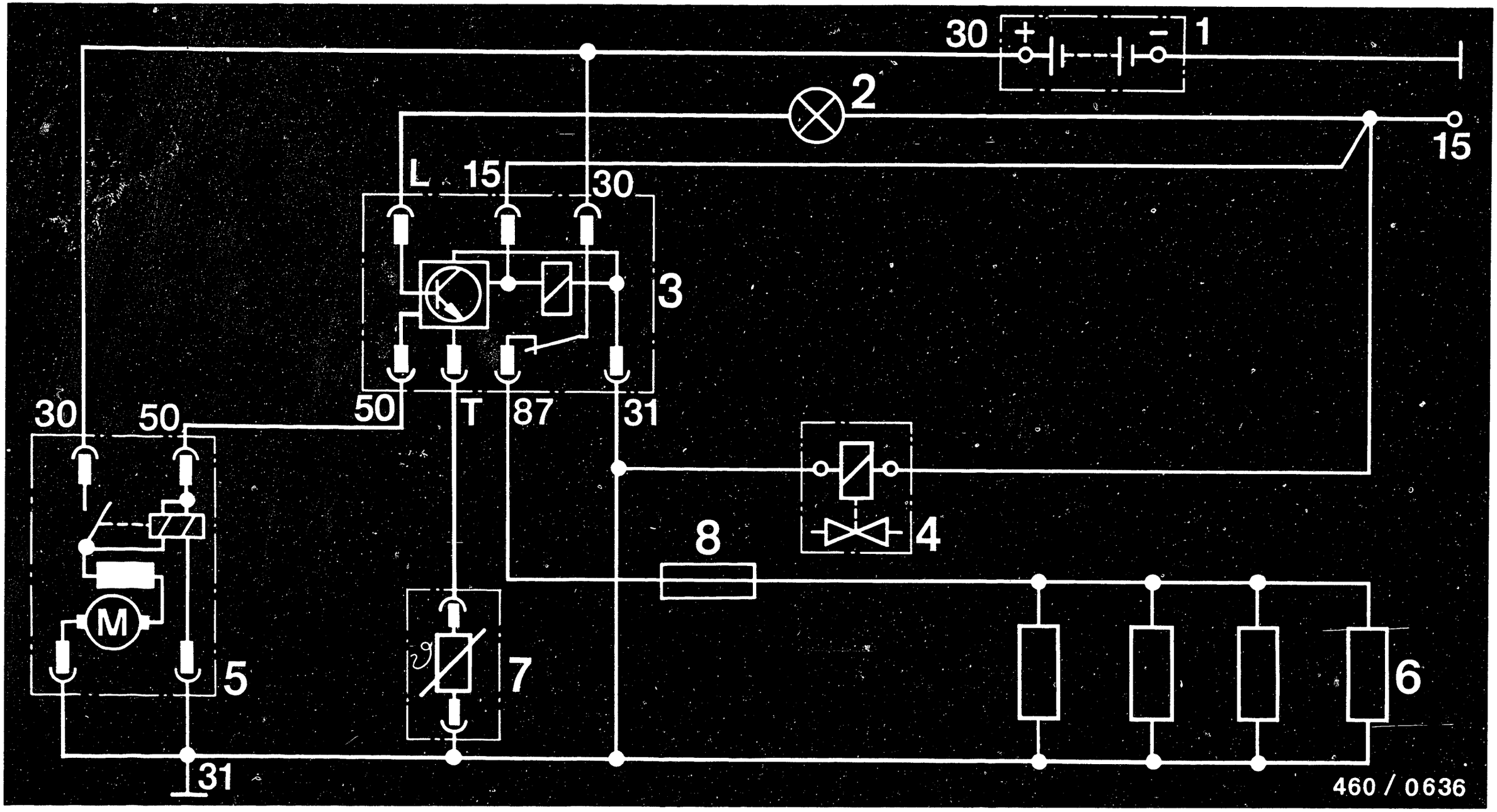
no → Repair connection between fuse S 12 and relay terminal 86.

yes ↓

Repair connection from terminal 85 of relay to ground or replace relay.

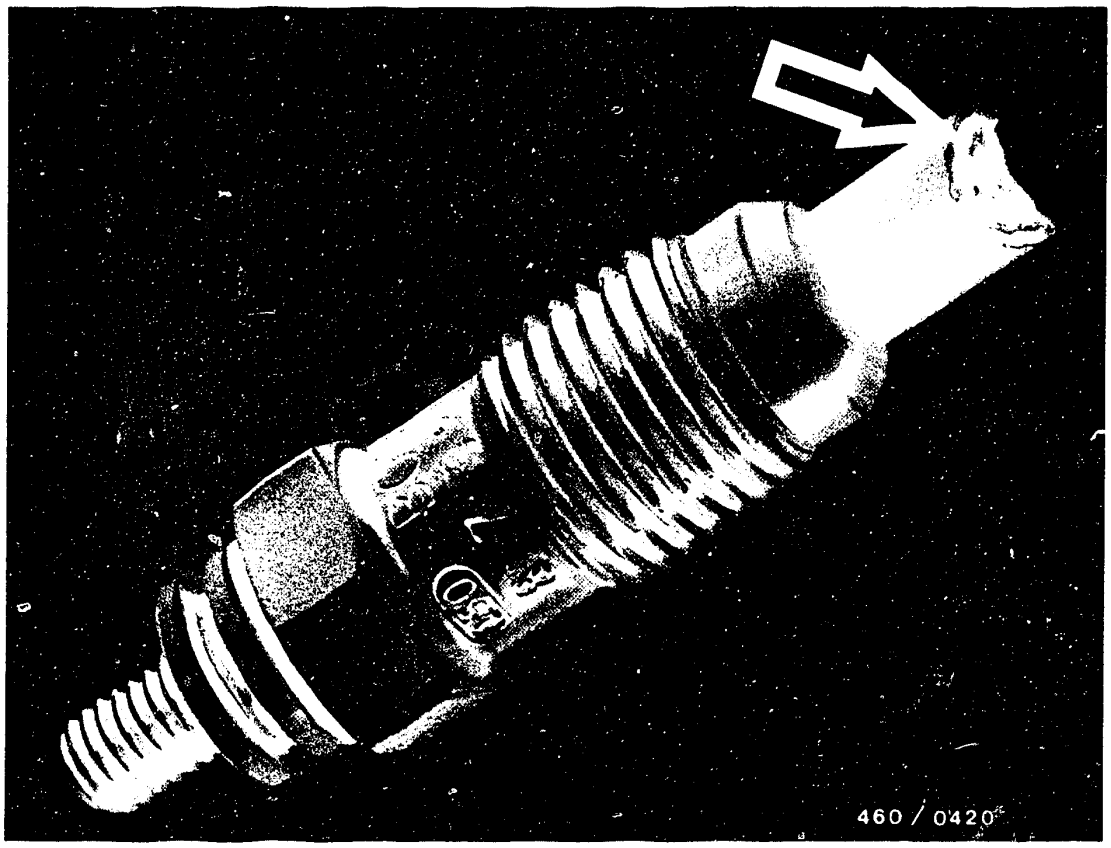


Pre-heating control relay
T = Temperature sensor
L = Pilot light



1 = Battery
2 = Visual indicator
3 = Glow duration control unit
4 = Solenoid-operated valve
5 = Starter
6 = Sheathed-element glow plugs
7 = Temperature sensor
8 = 80 A fuse

21.3 Wiring diagram for pre-heating system



Note:

Glow plugs with burned heating elements

Glow plugs with burned heating elements are often the result of nozzle malfunction.

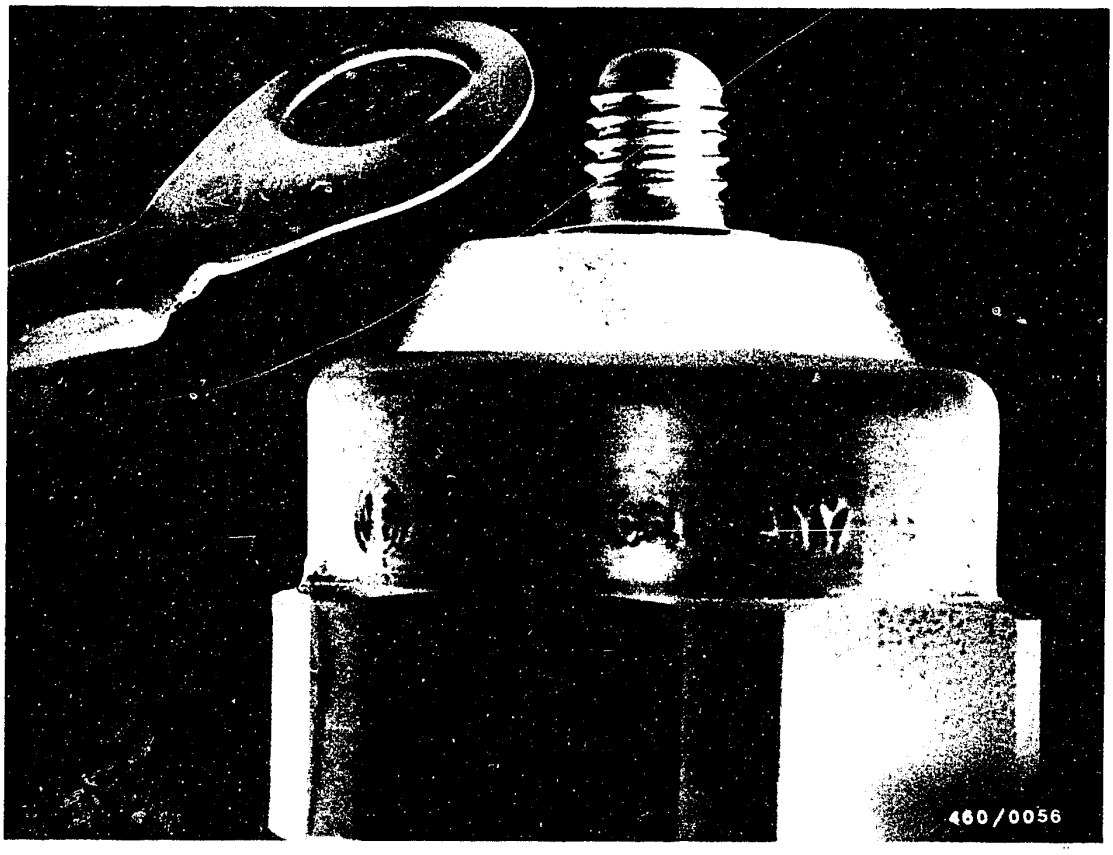
If plugs with burned elements are found(see photo), it is not sufficient simply to replace them. The nozzles must also be checked for spray pattern, chattering, pressure and leaktightness.

22. Testing injection timing device

Series VE..F.. distributor-type injection pumps have built-in injection timing devices.

The injection pump must be removed to test the timing device.

The timing device is tested on the injection pump test bench.



23. Measuring engine compression and pressure loss

23.1 Measuring engine compression

Place new recording card in compression tracer.

Attach high-pressure hose to tracer.

Turn off engine.

To avoid injection of fuel, remove lead from shutoff solenoid of distributor-type injection pump (see photo).

Unscrew nozzle holder.

Crank engine several times with starter to remove loose deposits from compression chamber.

Screw in nipple, 622 010 3219. (Check for tight seal when screwing nipple into nozzle holder hole).

Attach high-pressure hose of compression tracer to nipple.

When performing the following steps, pay particular attention to the first compression stroke.

Operate starter until indicated pressure on compression tracer stops rising.

Relieve compression tracer by pressing vent valve.

Tracer needle returns to initial position.

Move recording card to next position.

Screw nipple into remaining cylinders and repeat above procedure.

Compression	Permissible cylinder deviation
28 ... 34 bar	max. 5 bar

23.1.1 Evaluation of recording card

1. Normal pressure rise

If piston rings and valves are good, the first compression stroke will show the greatest pressure increase. Each succeeding stroke increases the compression until maximum pressure is reached.

2. Step-by-step pressure rise

If the compression increases in steps with each stroke beginning with the first, this indicates burned valve seats or faulty valve guides.

3. Low maximum pressure

If the maximum compression of all cylinders is too low, this indicates defective pistons, piston rings or valves.
Insufficient compression in two adjacent cylinders indicates a leaky head gasket.

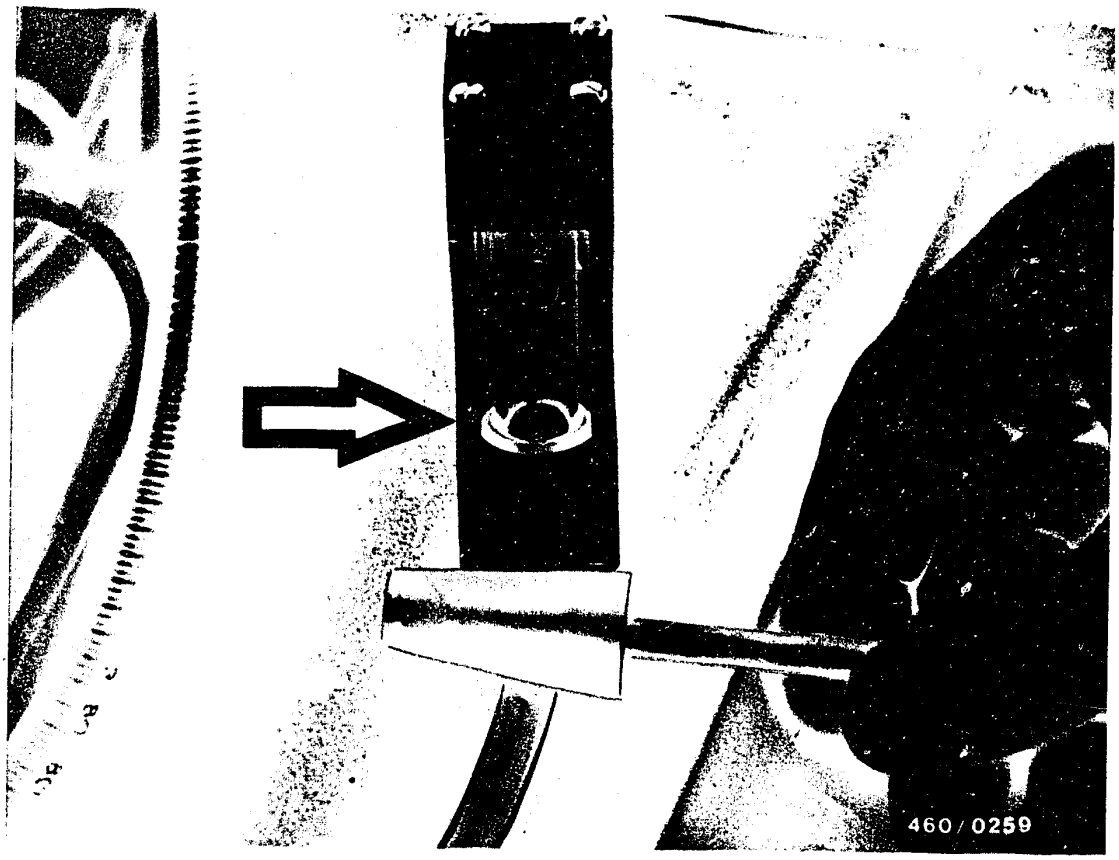
4. Non-uniform compression

If one cylinder shows significantly lower compression, proceed as follows:
Add 2 ... 3 cm^3 of engine oil through sheathed-element glow plug or nozzle holder hole. Operate starter briefly.

Repeat tests and compare recording cards. If the second test indicates significantly higher compression, the cylinder or piston rings are worn.
If the results are the same, bad valves are the problem.

5. Uniform compression

Uniform compression, in addition to compression which is as high as possible, is also very important for smooth engine performance.



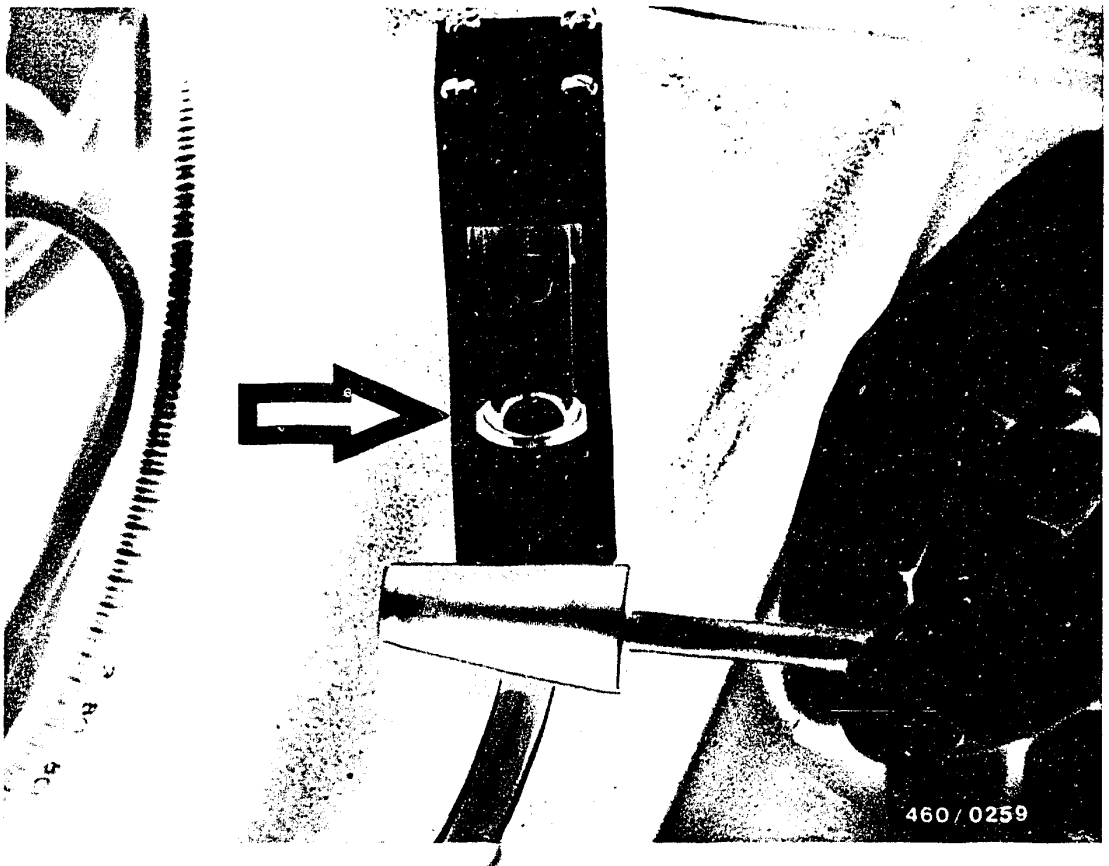
23.2 Measuring engine compression loss

Compression loss is measured using BOSH compression loss tester 0 681 001 901 (EFAW 210 A).

Cylinders must be measured at TDC.

TDC can be located using dead center (DC) finder 1 688 132 025 (included with compression loss tester).

Make measurements with engine at operating temperature (water temperature approx. 80°C).



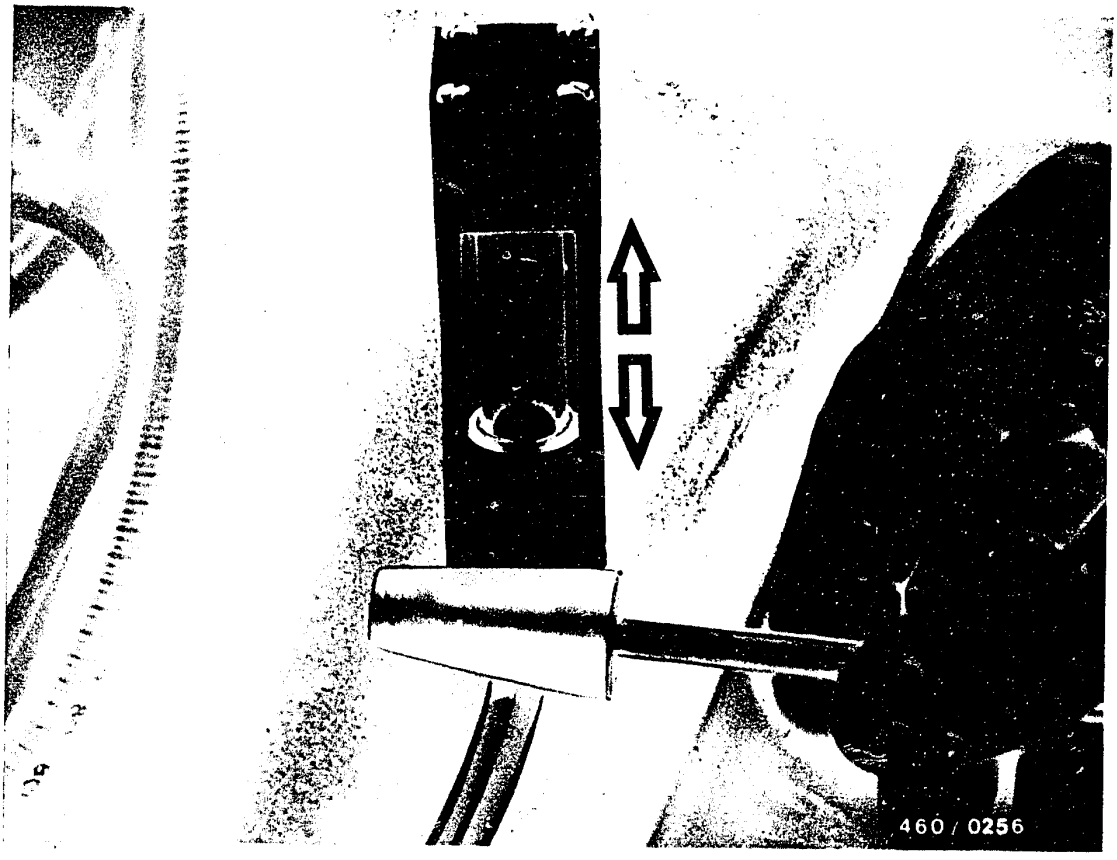
23.2.1 Locating TDC

Remove sheathed-element glow plug from 1st cylinder.

Place rubber plug of DC finder in glow plug hole.

Attach glass cylinder with magnet in as vertical a position as possible in engine compartment.
The piston of the unit must be clearly visible.

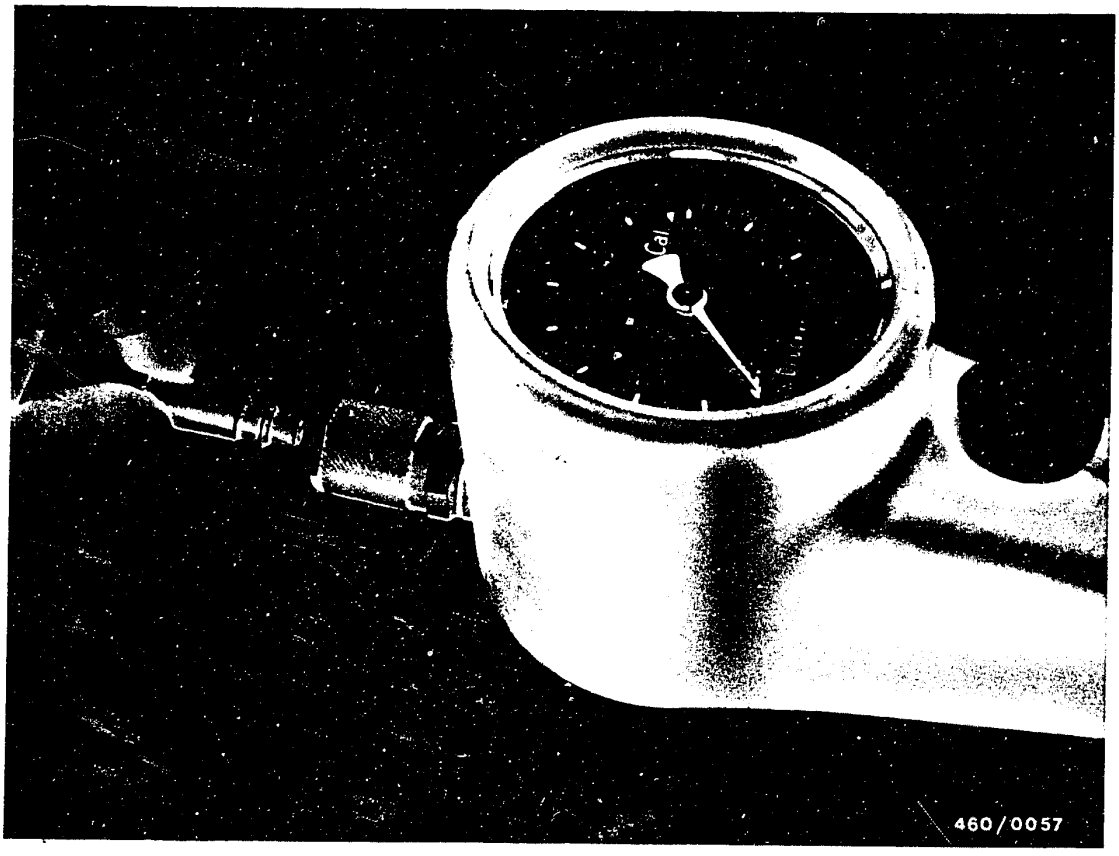
Turn engine by hand in normal direction of rotation.
(If necessary, shift into gear and push vehicle.)



During the compression stroke the piston of the DC finder is pushed upward.

If the cylinder piston moves past TDC, the piston of the DC finder moves downward immediately.

Find TDC by carefully rotating crankshaft back and forth.



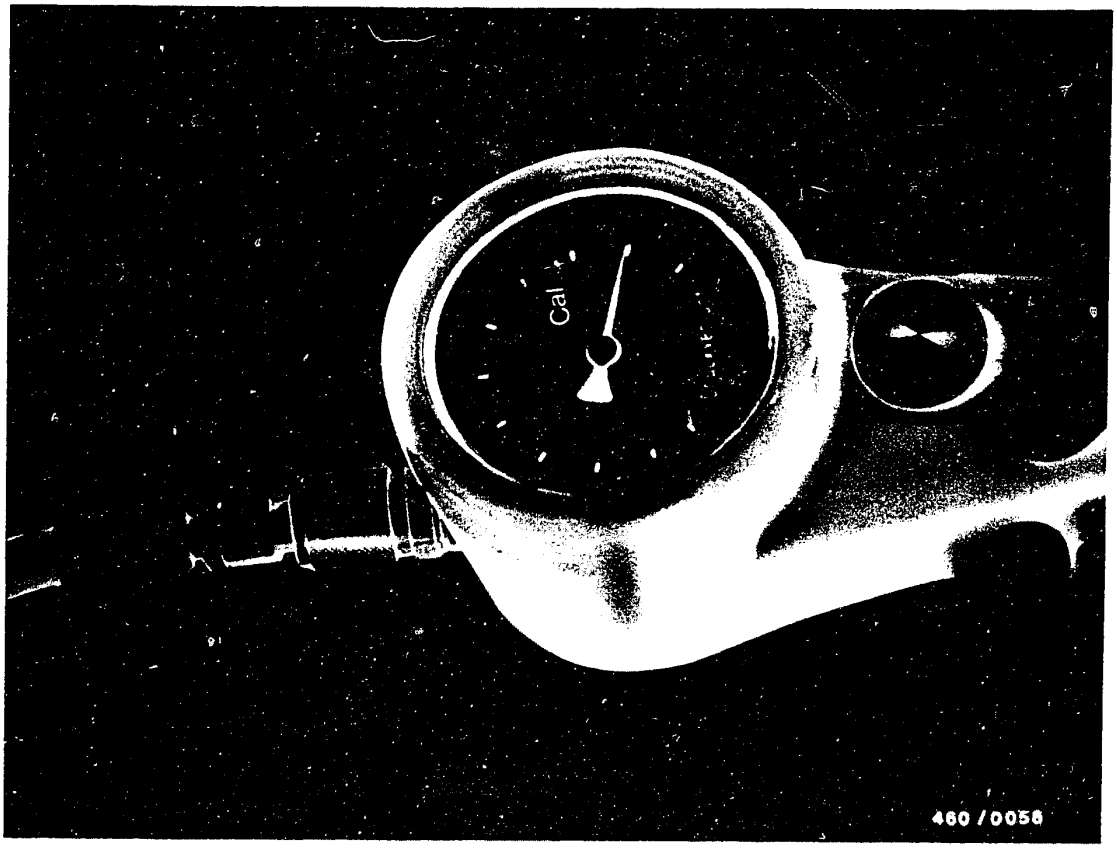
23.2.2 Measuring pressure loss

Connect tester to shop air supply.

Connect test nozzle 1 680 363 036.

Set pressure loss to 23 ±1% ("Cal." marking) with knurled screw of pressure regulator.

(Pointer must indicate pressure loss approaching 0% -- tester check.)



Remove nozzle holder and replace with connecting parts set 1 687 010 016 and nipple 622 010 3219. Then attach test hose.

Put vehicle in gear and apply hand brake.

Connect test hose to tester.

Read pressure loss in percent on tester.

Note:

Before measuring next cylinder, use starter to crank engine briefly without pre-heating to reapply oil film.

23.2.3 Evaluating test results

Pressure loss should not exceed 25%.

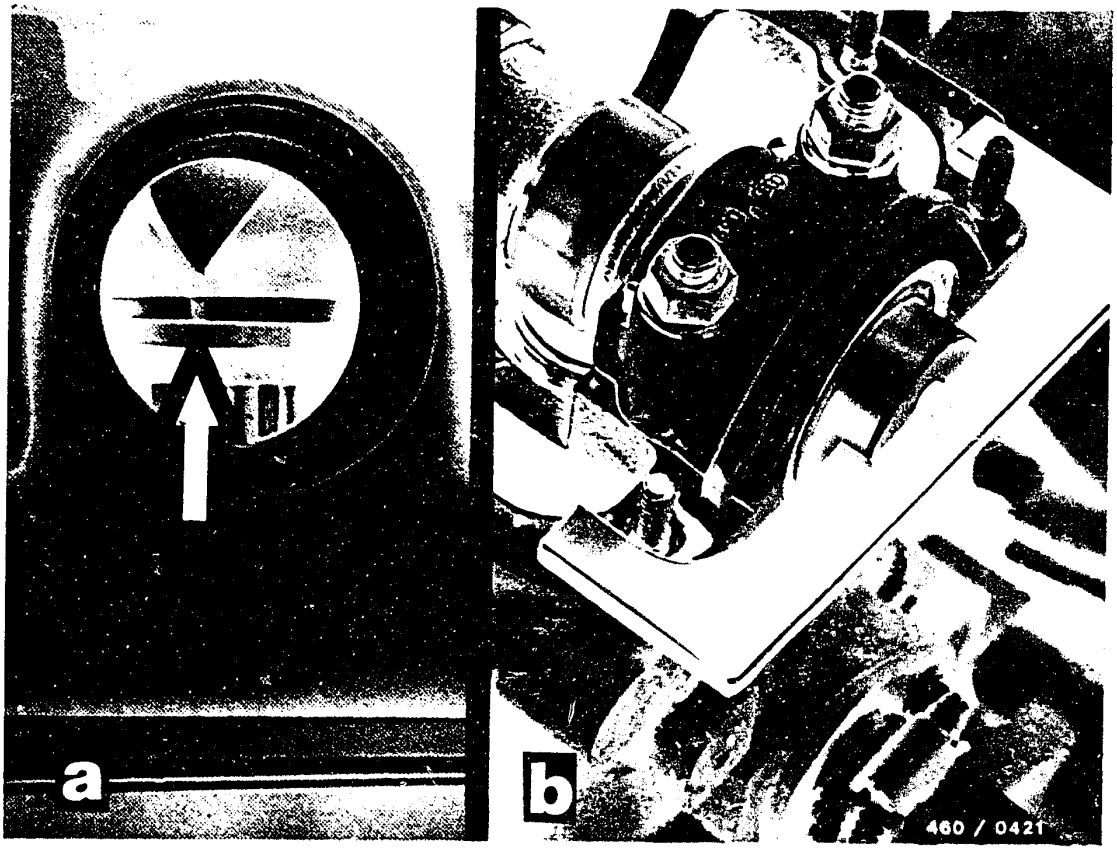
Differences of up to 10% between cylinders are not significant.
Major leaks can be localized due to noise made by outrush of air.

Check for noise in following areas:

Source of noise	Possible cause
Intake manifold (remove air filter)	Intake valve
Exhaust manifold	Exhaust valve
Oil filler neck on engine	Piston, piston rings
Coolant filler neck (air bubbles)	Head gasket

To better localize the cause of noise, add approx. 2 ... 3 cm^3 of engine oil to cylinder.
Repeat test.
If pressure loss is now much less, piston or piston rings are bad.

The pressure loss of a new engine which is not yet broken in (under 5,000 km) may be greater than loss after break-in period.



24. Removing injection pump

Disconnect negative cable at battery.

Remove toothed belt guard and cylinder head.

Remove air filter.

Rotate crankshaft until TDC mark (1st cylinder) on flywheel is aligned with mating mark (see arrow in Fig. a).

Lock camshaft with KDEP 1117 setting straightedge and center straightedge as follows (Fig. b).

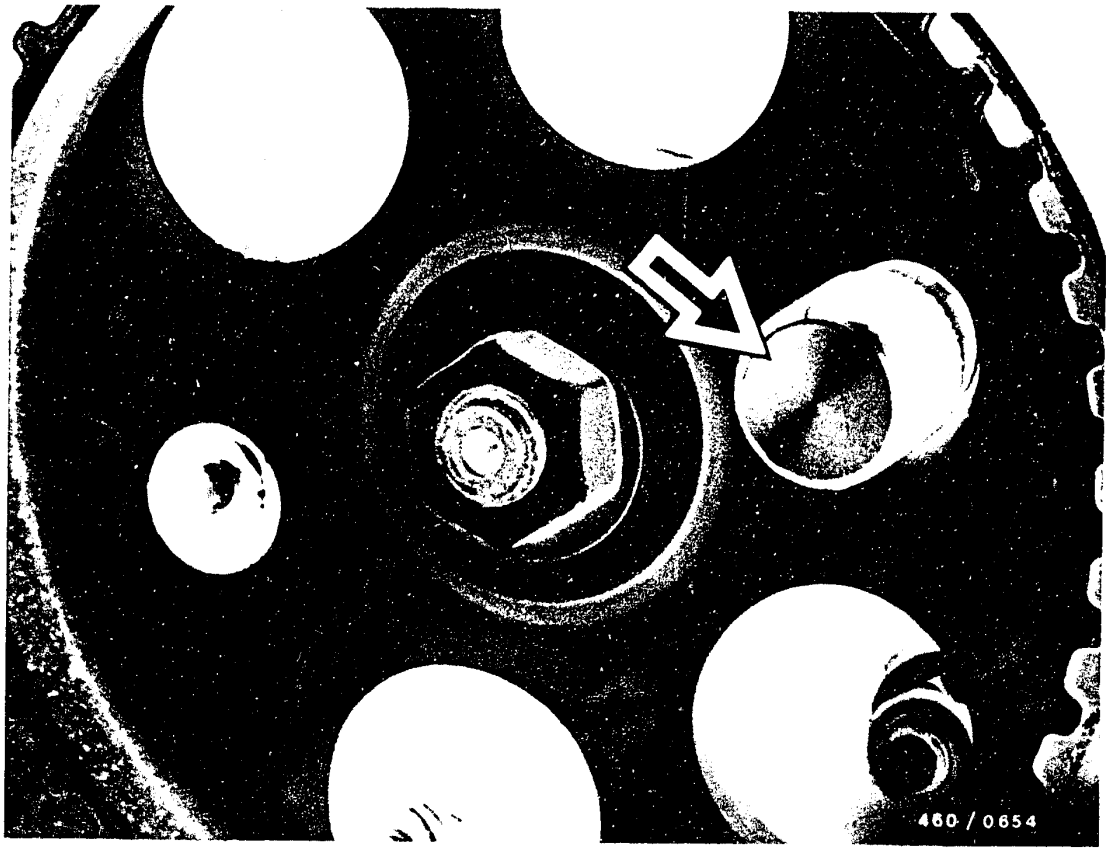
Rotate locked camshaft until end of the setting straightedge touches cylinder head.

Measure resulting clearance at other end of straightedge with a feeler gauge.

Divide clearance in half and insert feeler gauge of this thickness between straightedge and cylinder head.

Now rotate camshaft so that straightedge rests against feeler gauge.

Insert second feeler gauge of same thickness at other end between straightedge and cylinder head.

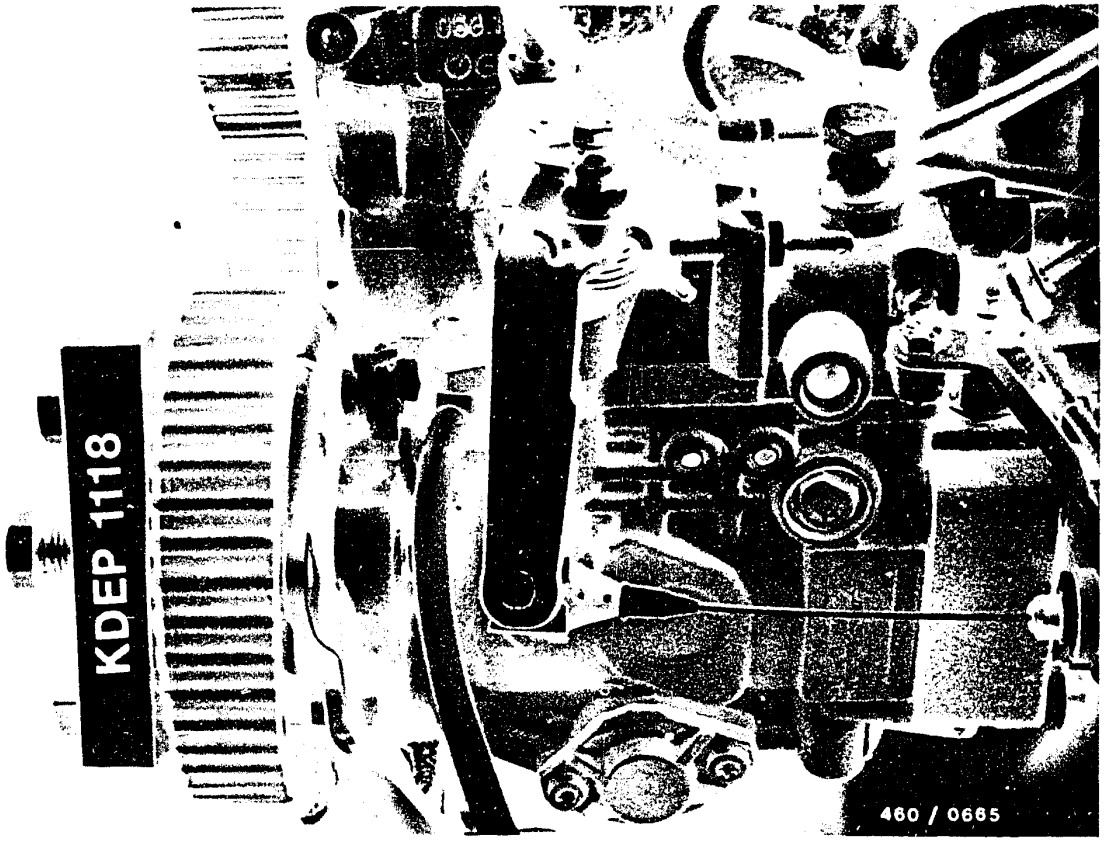


Unscrew camshaft sprocket mounting bolt ½ turn and loosen sprocket from conical seat by striking with rubber mallet.

Remove toothed belt from camshaft sprocket and injection pump sprocket.

Secure injection pump sprocket with KDEP 1122 securing pin (arrow).

Loosen -- but do not completely remove -- injection pump sprocket mounting nut.

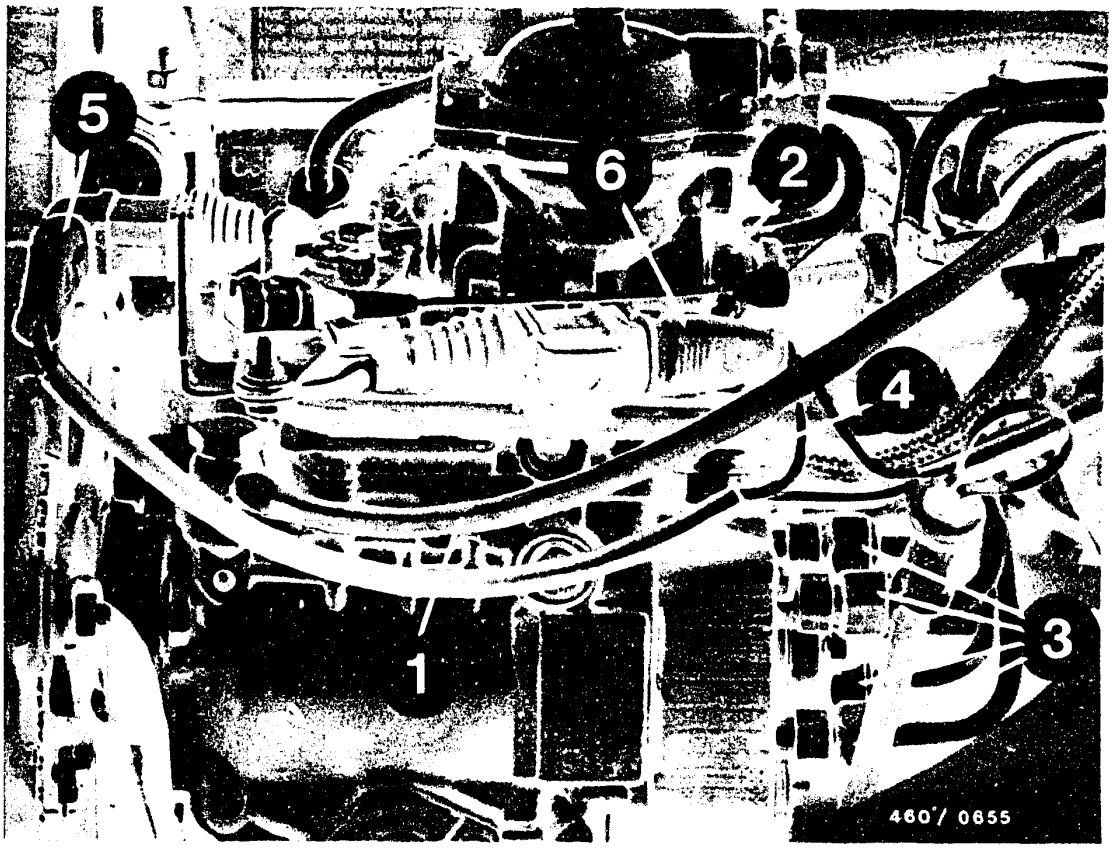


Attach KDEP 1118 puller (arrow) to pump drive sprocket.

Pull pump drive sprocket off conical seat of camshaft.

Remove KDEP 1118 puller.

Unscrew mounting nut completely and remove injection pump sprocket.

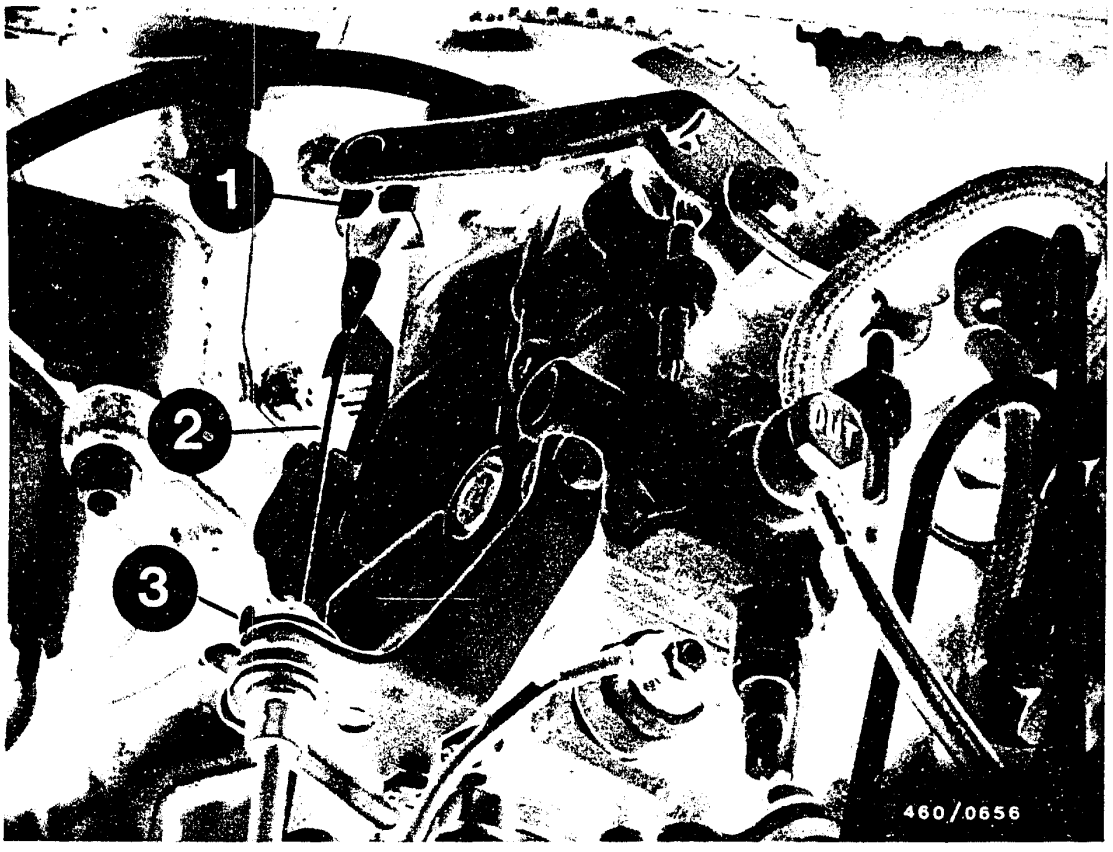


Disconnect fuel inlet line (1) and return line (2) at injection pump.

Loosen injection lines (3) with KDEP 1115 open-end wrench.

Note:

Back up demivery valve holders with wrench to prevent loosening.
Remove connectors (5 and 6) for switching indicator.



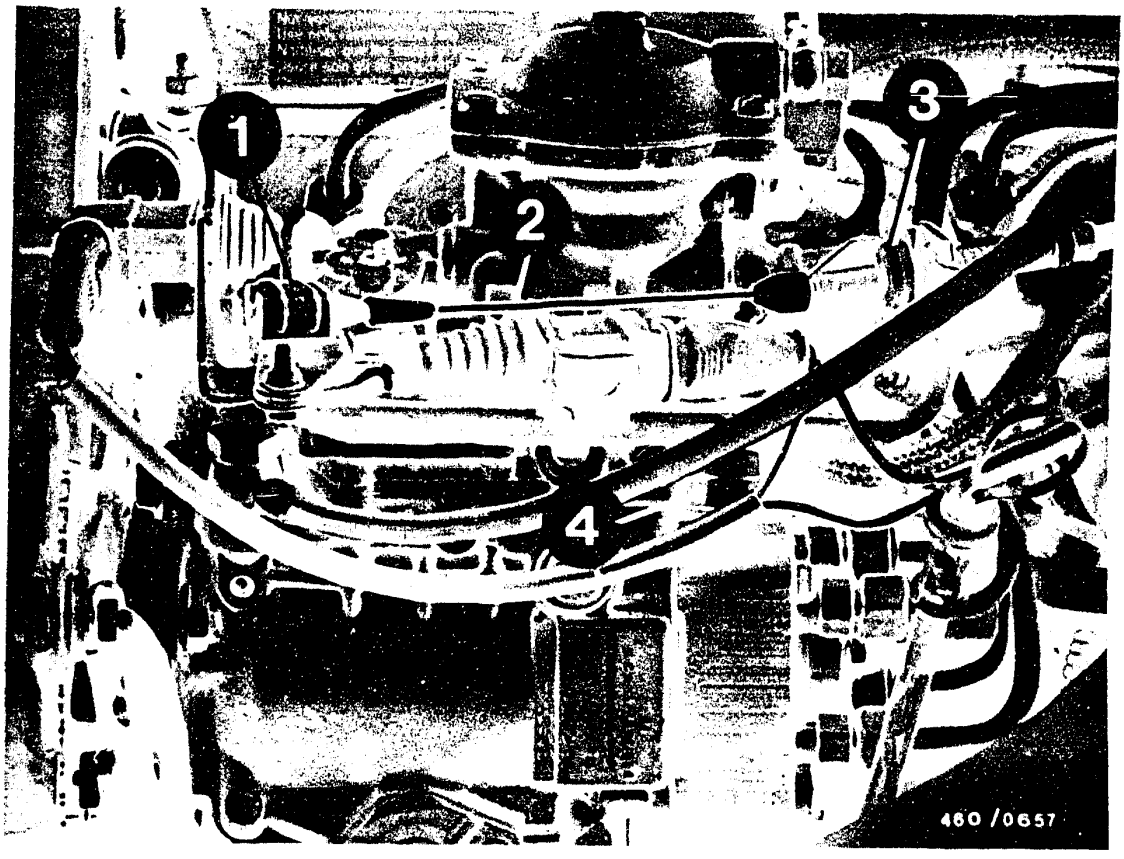
Only for diesel engines:

Disconnect control cable for cold-start!accelerator and bowden cable at injection pump lever. Remove clip (1).

Unhook bowden cable (2) at injection pump lever.

Remove clip (3) and lay bowden cable aside.

Disconnect control cable for cold-start accelerator at bearing pin and remove clip on bracket.



Only for turbo-diesel engines :

Disconnect control cable for cold-start accelerator and bowden cable at injection pump lever.

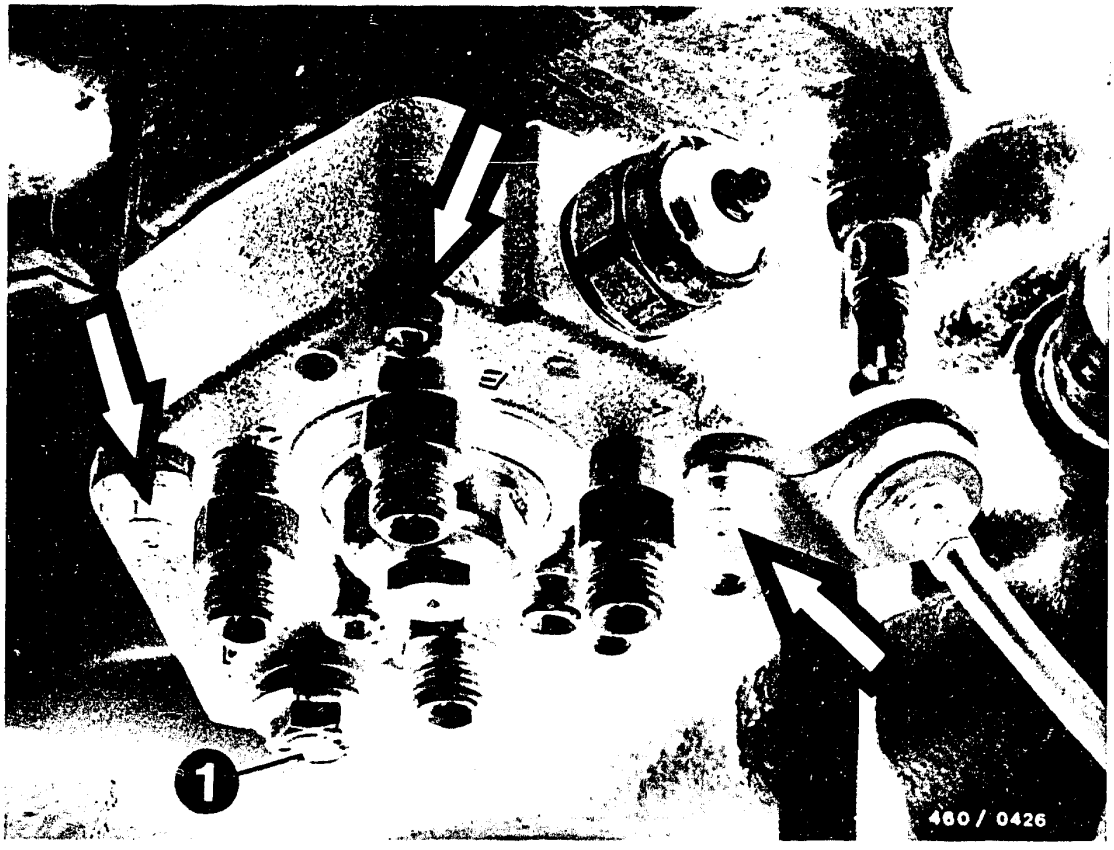
Remove clip (1).

Unhook bowden cable (2) at injection pump lever.

Remove clip (3) and lay bowden cable aside.

Disconnect control cable for cold-start accelerator at bearing pin and remove clip on bracket.

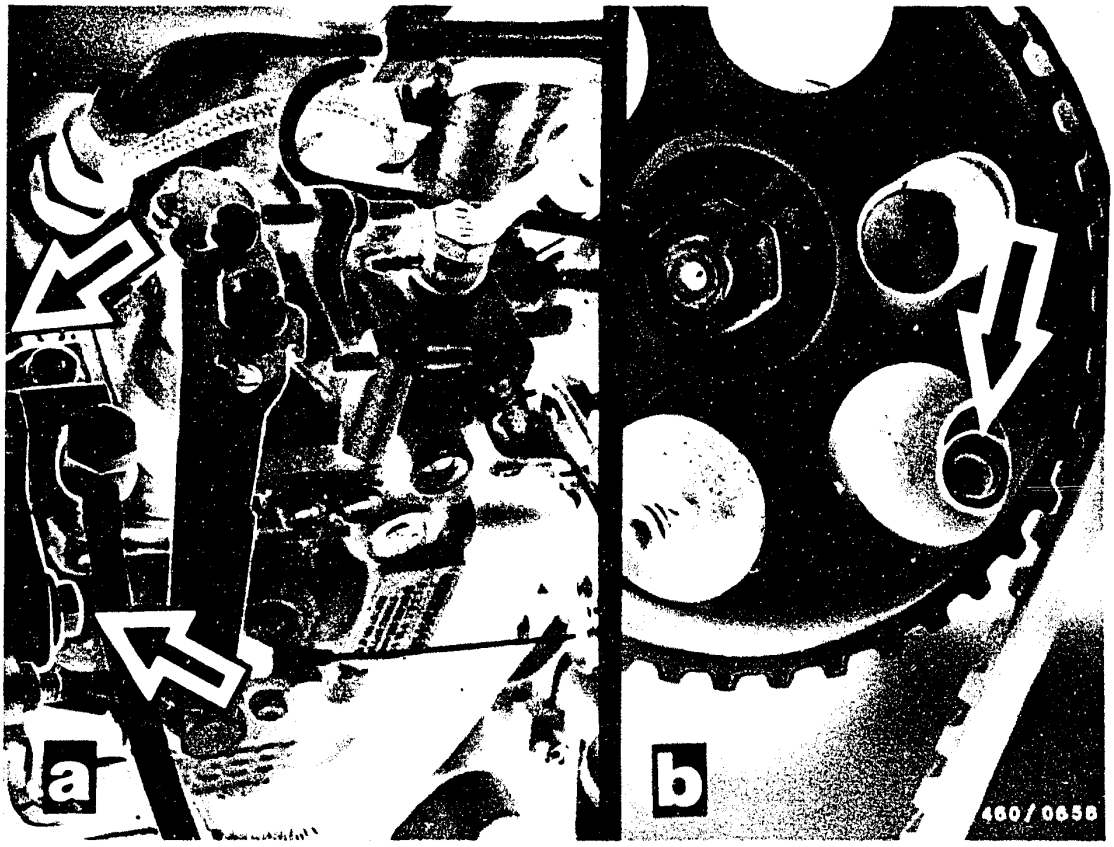
Disconnect wire to electric shutoff device (4).



Unscrew mounting bolt (1) from support bracket.

Note:

Under no circumstances loosen the distributor head mounting screws (arrows).

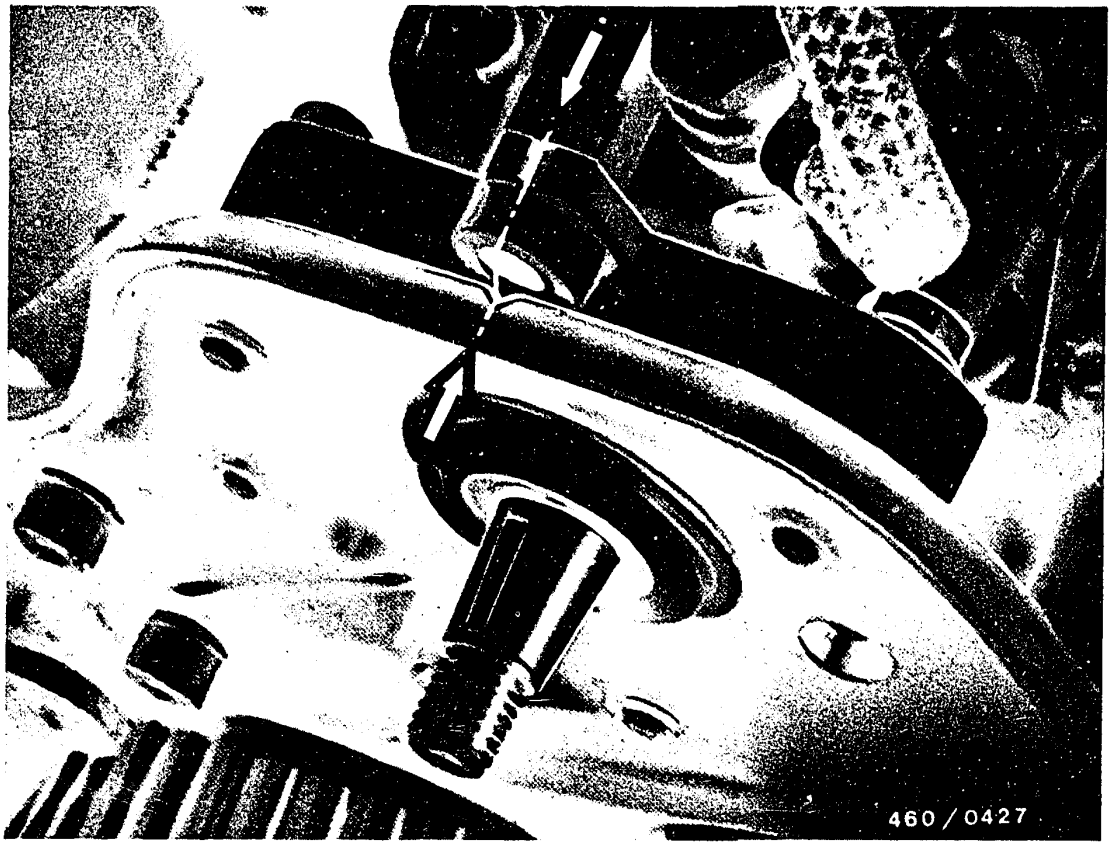


Unscrew injection pump mounting bolts at pump flange using KDEP 1115 open-end wrench (only one bolt visible in photo).

Note: - only for 1.6 l engine

Bottom mounting bolt on bracket is screwed in from drive side (shown at arrow in Fig. b).

Lift out injection pump.

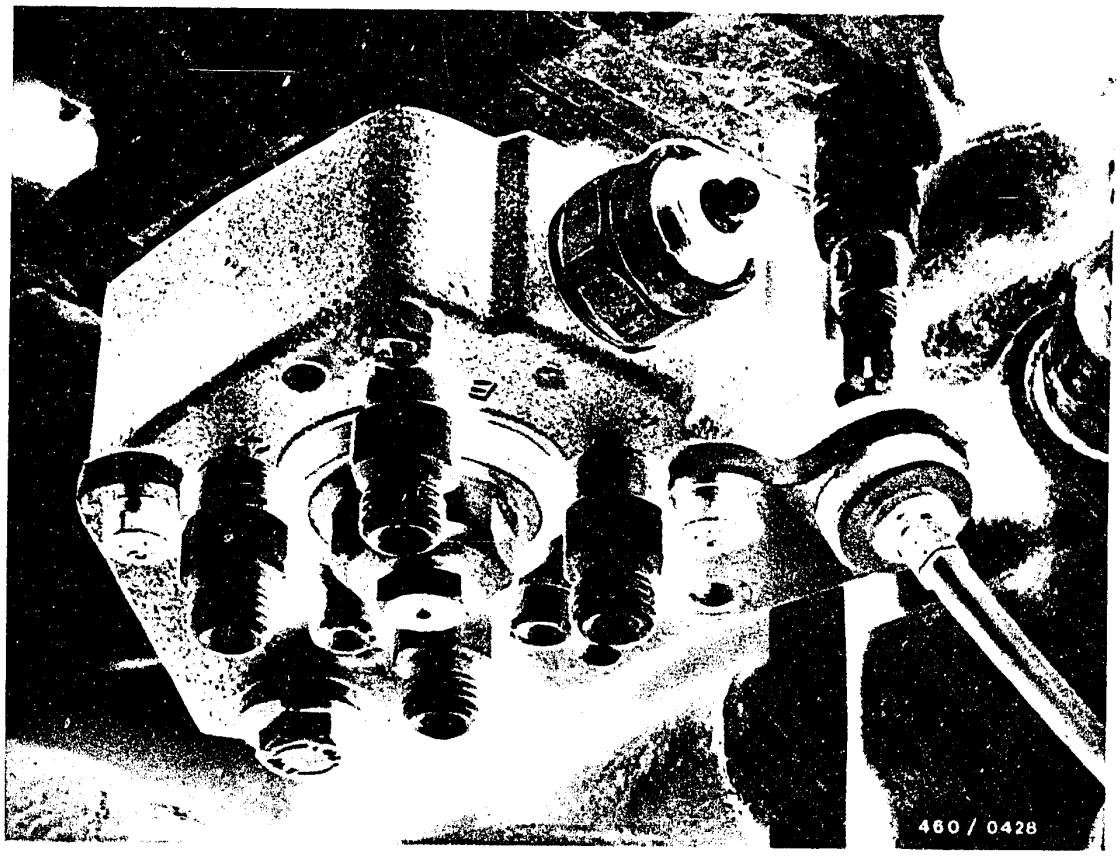


25. Installing injection pump

Attach control cable for cold-start accelerator.

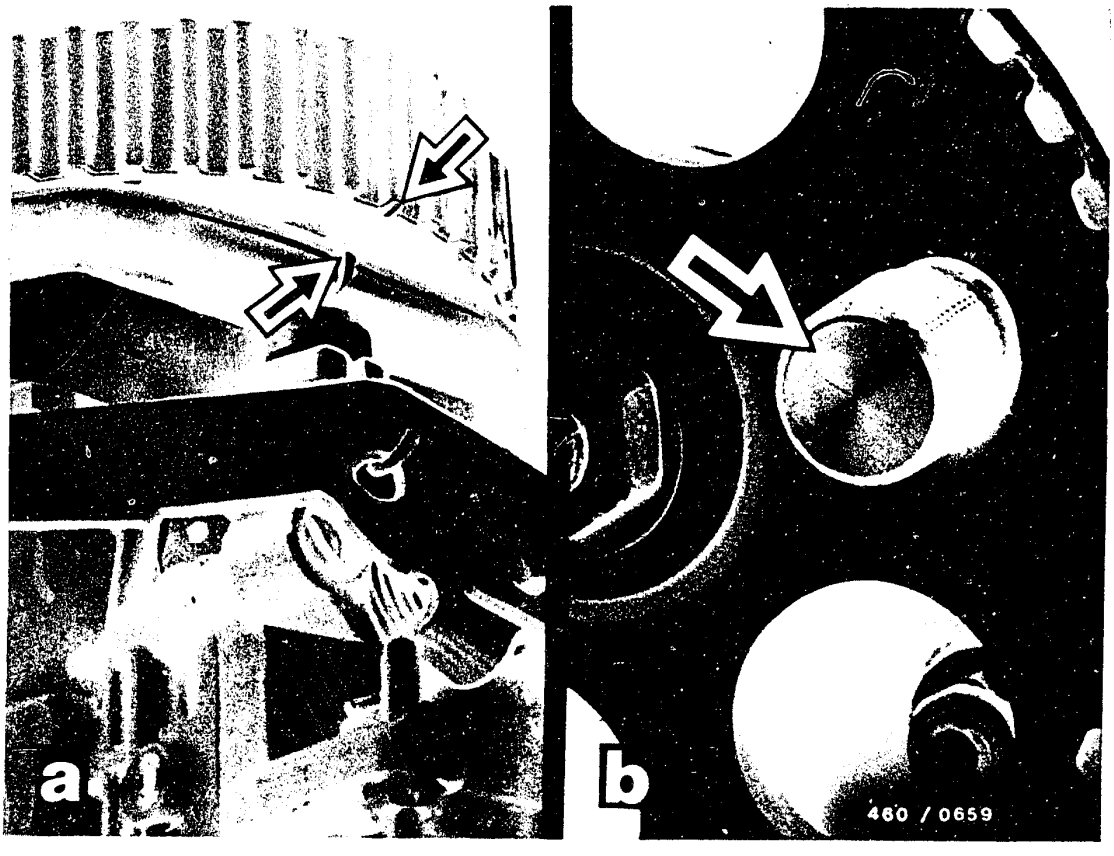
Install injection pump so that marks on pump and bracket match (arrow).

Replace injection pump mounting bolts and tighten with light torque.



Align support bracket on injection pump distributor head so that it rests unstressed against cylinder block and distributor head.

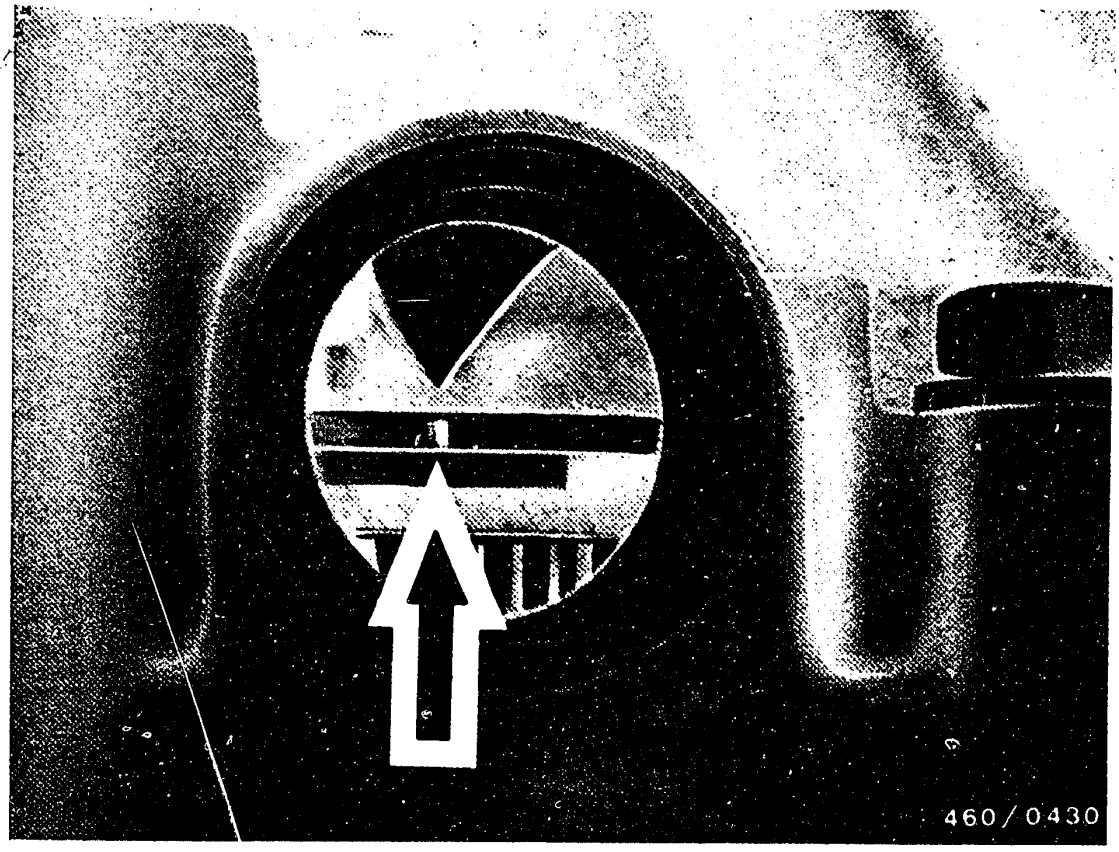
Tighten down support bracket.



Mount injection pump sprocket (woodruff key must be inserted into conical seat of pump drive shaft). Rotate sprocket so that marks on sprocket and bracket match (shown at arrows in Fig. a).

Secure injection pump sprocket using KDEP 1122 securing pin (shown at arrow in Fig. b).

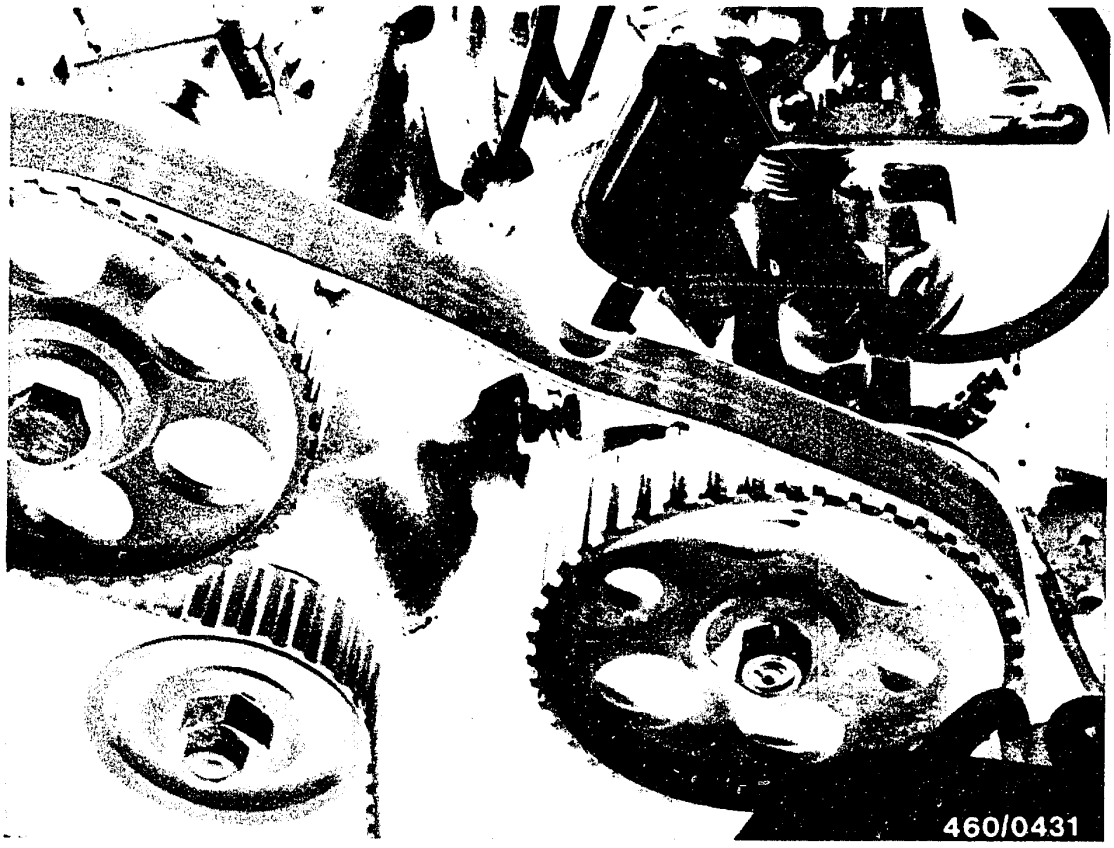
Tighten mounting nut to 45 Nm.



Make sure TDC mark (cylinder 1) on flywheel is aligned with mating mark (arrow).

Mount toothed belt on camshaft sprocket.

Tighten camshaft sprocket mounting bolt leaving it loose enough so that camshaft sprocket can still be turned by hand.

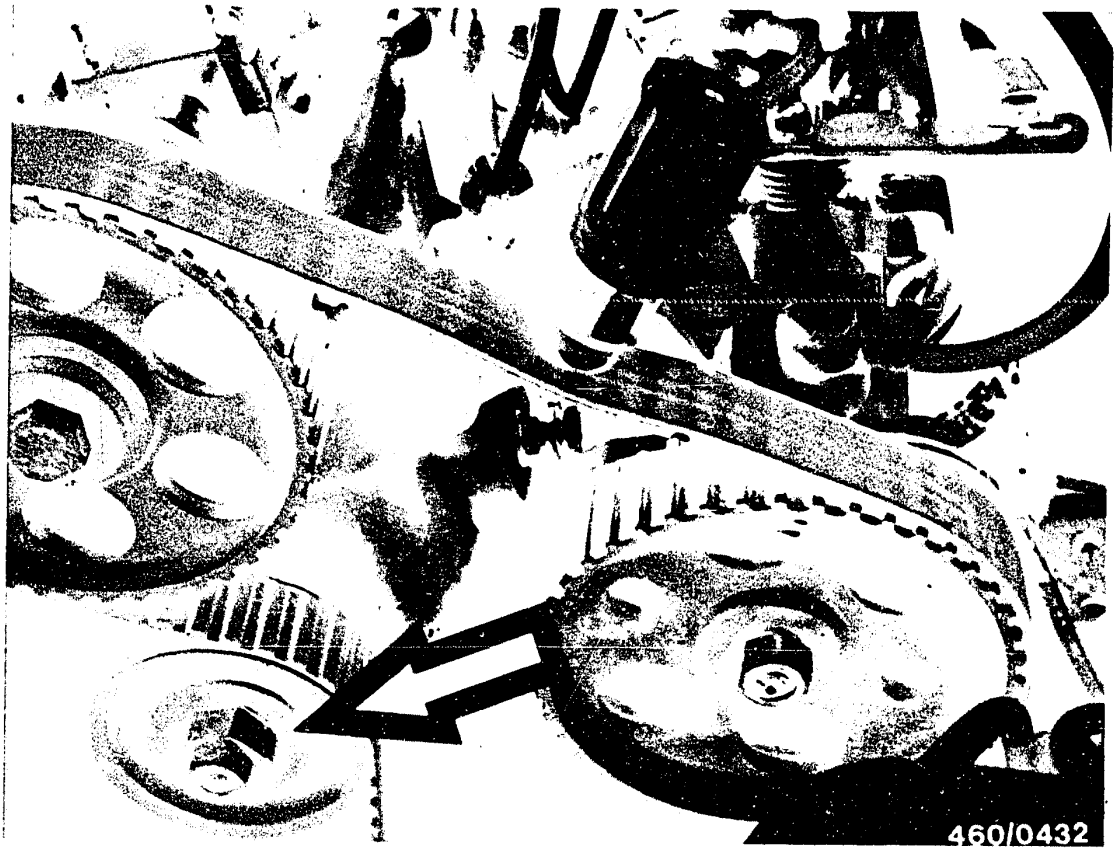


Remove securing pin from injection pump sprocket.

Check tension of toothed belt using KDEP 1121 belt tension checker:

Turn vernier sleeve until bottom sleeve edge coincides with marking on feeler.

Read off measurement: set value = scale value 12 - 13



If belt tension is not within this tolerance, adjust at tensioning roller (arrow); turn roller to right when making adjustment.

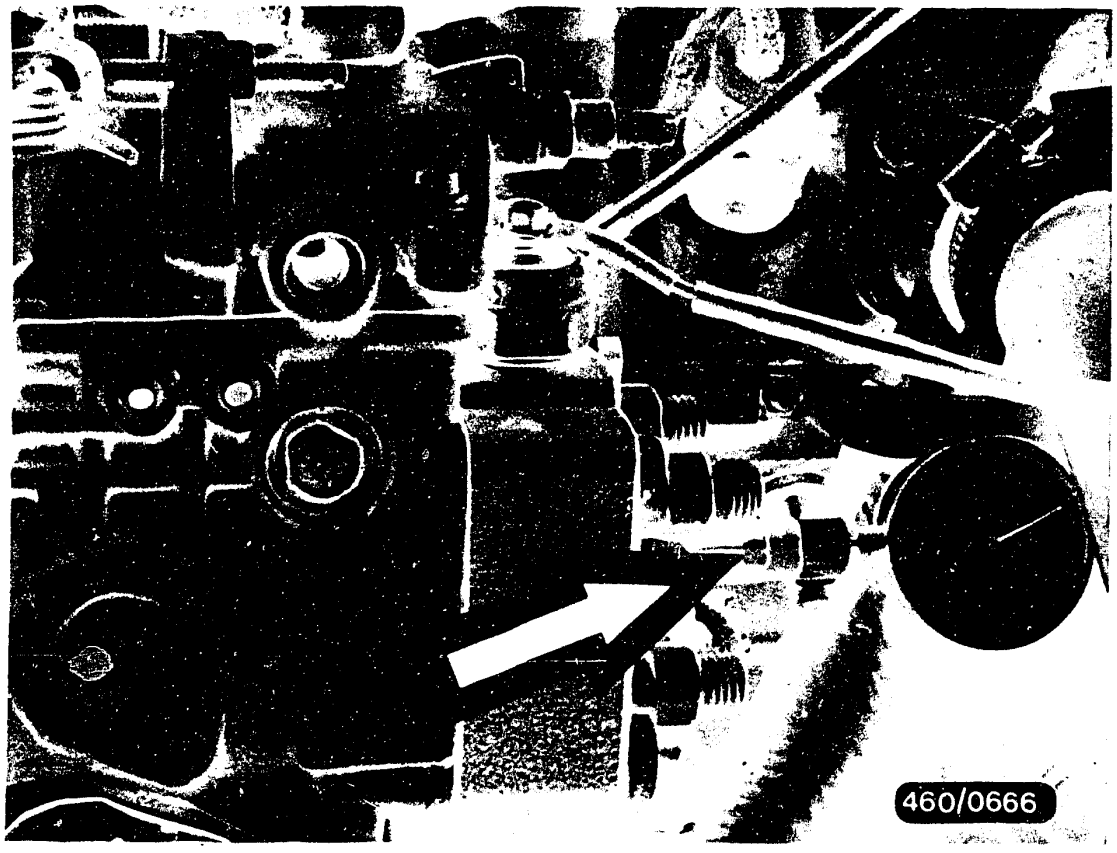
Note:

On 1.6 l engines use nut driver such as Hazet 2587.

Tighten camshaft sprocket to 45 Nm.

Remove setting straightedge.

Rotate crankshaft twice, then recheck belt tension.



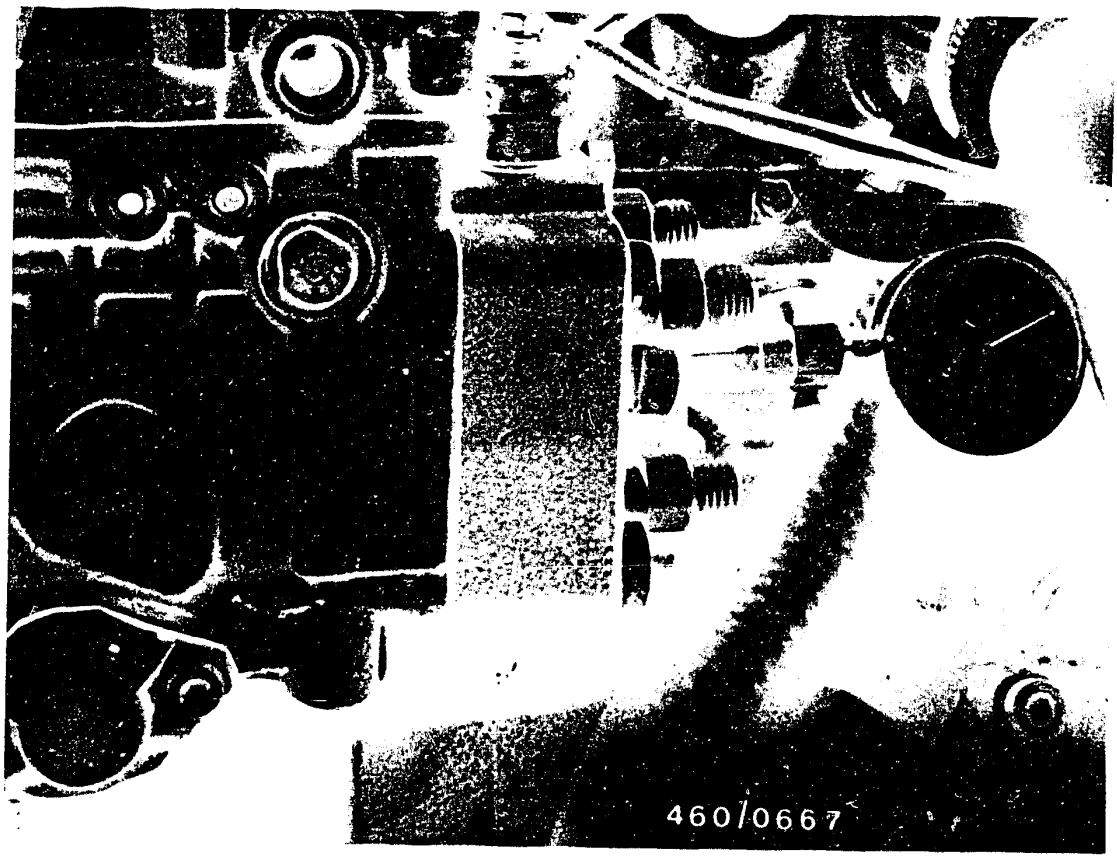
Unscrew vent screw from plug (triangle-head bolt) in center of distributor head.

Screw KDEP 1085 measuring tool (arrow) into vent screw hole.

Insert miniature dial indicator with measuring adapter into KDEP 1085 measuring tool.

Note:

Cold-start accelerator must be in zero position when checking and adjusting nominal start of pump delivery.



Preload dial indicator to approx. 2.5 mm.

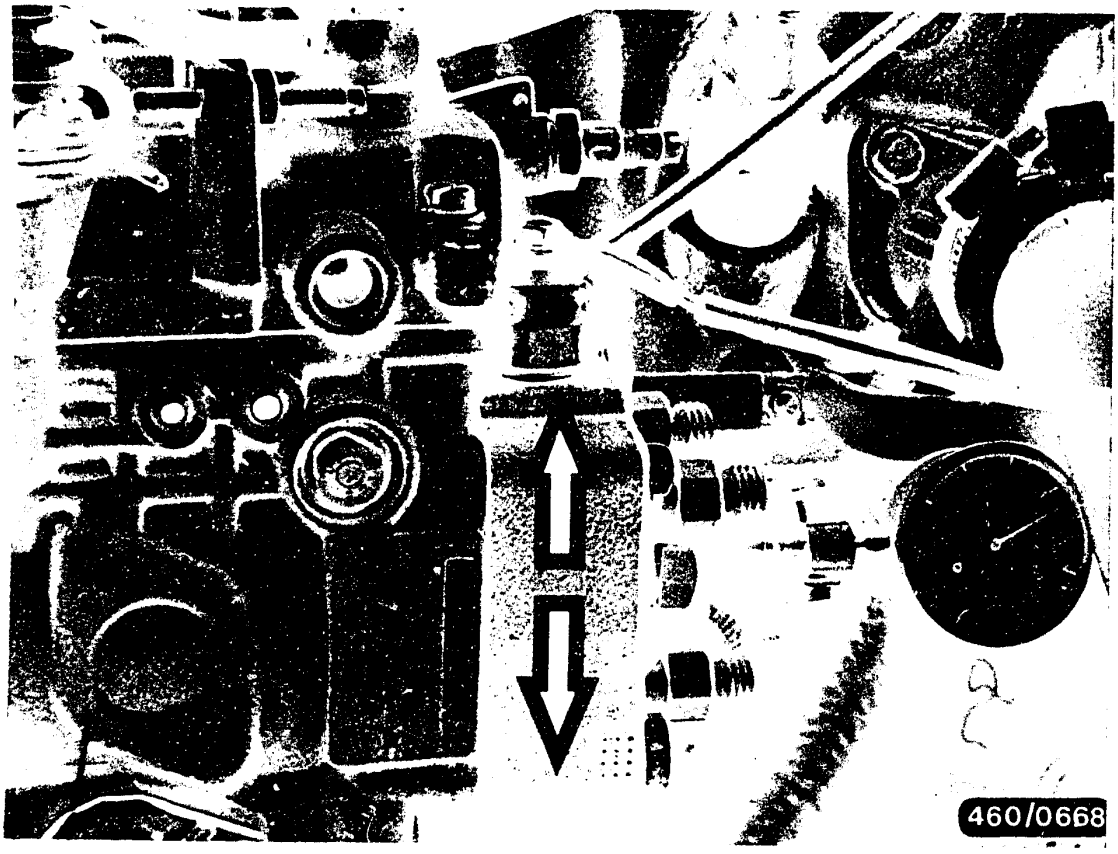
Rotate crankshaft slowly against direction of engine rotation until dial indicator pointer stops moving.

Preload dial indicator to approx. 1 mm and set to "0".

Rotate crankshaft in direction of engine rotation until TDC mark on flywheel and marks on injection pump sprocket and pump bracket coincide.

In this position, dial indicator must show following values:

Diesel engine	0.86 ±0.02 mm after BDC
Turbo-diesel engine	0.95 ±0.02 mm after BDC

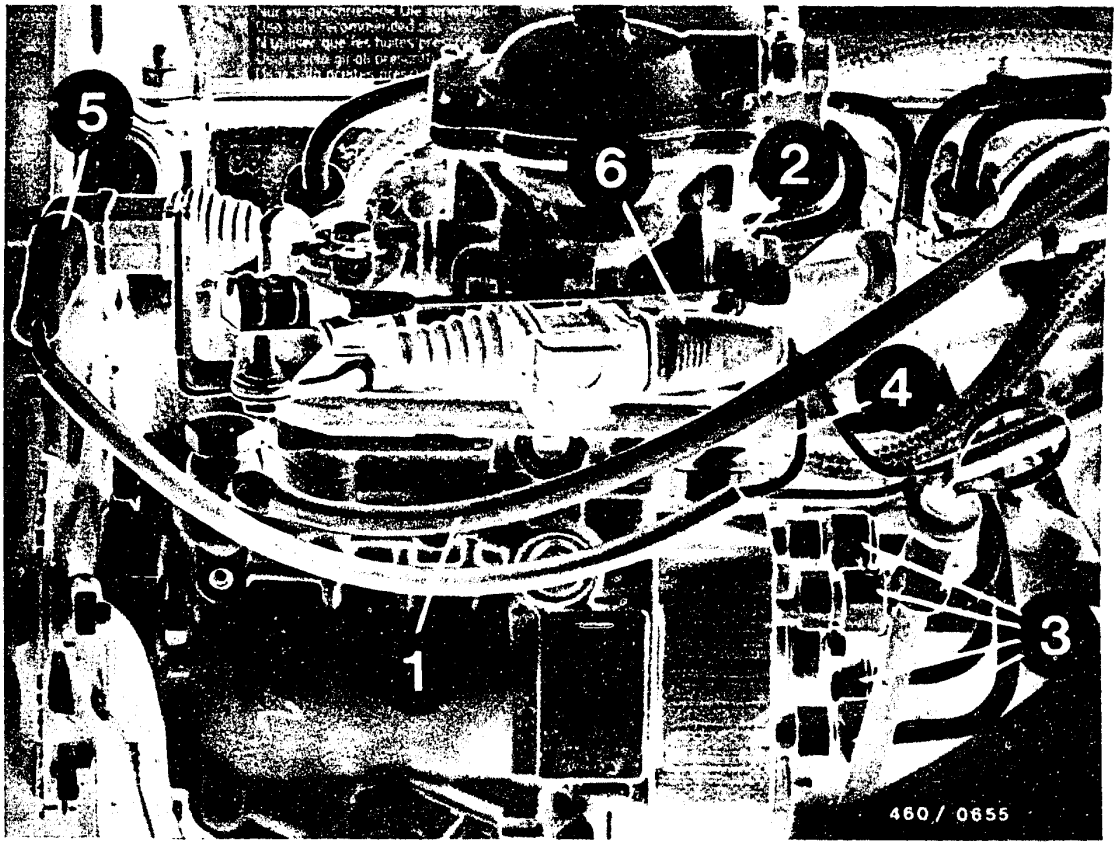


If retiming is necessary, loosen injection pump mounting bolts and swivel pump to following stroke:

Diesel engine	0.86 ±0.02 mm after BDC
Turbo-diesel engine	0.95 ±0.02 mm after BDC

Then tighten mounting bolts to 25 Nm, rotate crankshaft two revolutions and recheck setting.

Note:
The bottom mounting bolt on the bracket is screwed in from the drive side in the 1.6 l engine. Remove KDEP 1085 measuring tool and dial indicator. Replace vent screw with new gasket. Tighten down injection pump support bracket.

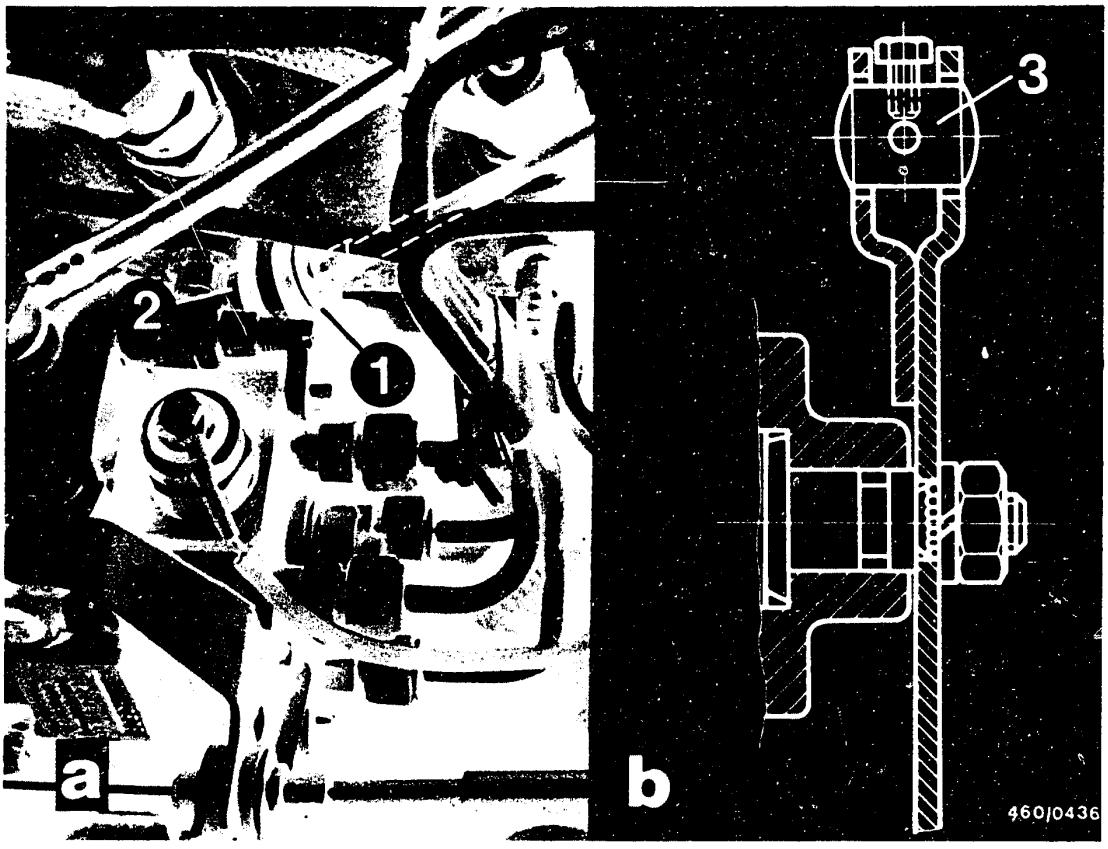


Reconnect fuel inlet line (1), return line (2) and injection lines (3) to injection pump. (When tightening injection lines, back up delivery valve holders with wrench to prevent loosening.)

Reconnect wire for electric shutoff device (4) and connectors (5 and 6) for switching indicator.

Note:

Do not switch the hollow bolts in the fuel inlet and return lines -- the hollow bolt for the return line has flow restriction holes and its head is marked "OUT".



Adjusting control cable for cold-start accelerator

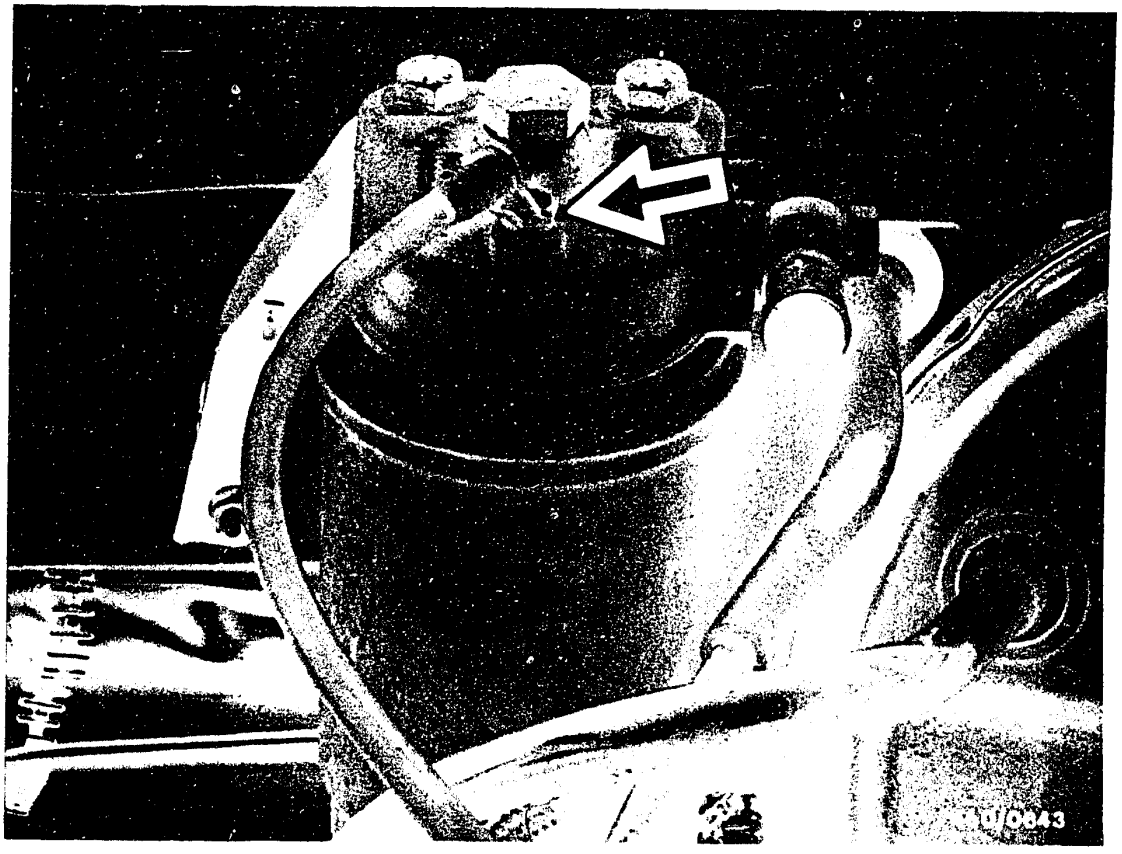
Slide washer (1) onto control cable and secure cable with clip (2).

Move stop lever to "0" position.

Pull cable taut and lock with clamp screw in bearing pin (3).

Reconnect negative cable at battery.

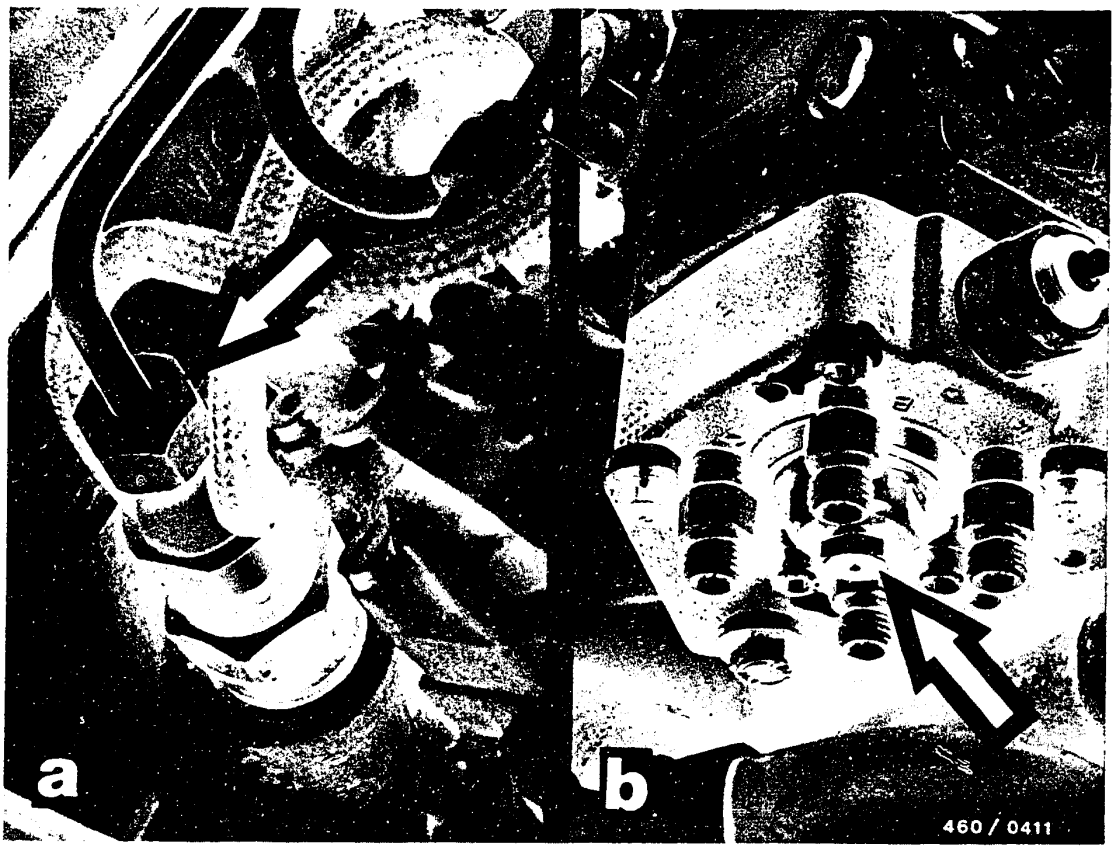
Bleed fuel injection system.



Bleeding fuel system

Fill fuel filter and injection pump with diesel fuel.

Tighten vent screw on fuel filter (shown at arrow in photo).



Unscrew injection pump vent screw (shown at arrow in Fig. b) several turns.

Loosen delivery line union nuts on nozzle holders (shown at arrow in Fig. a).

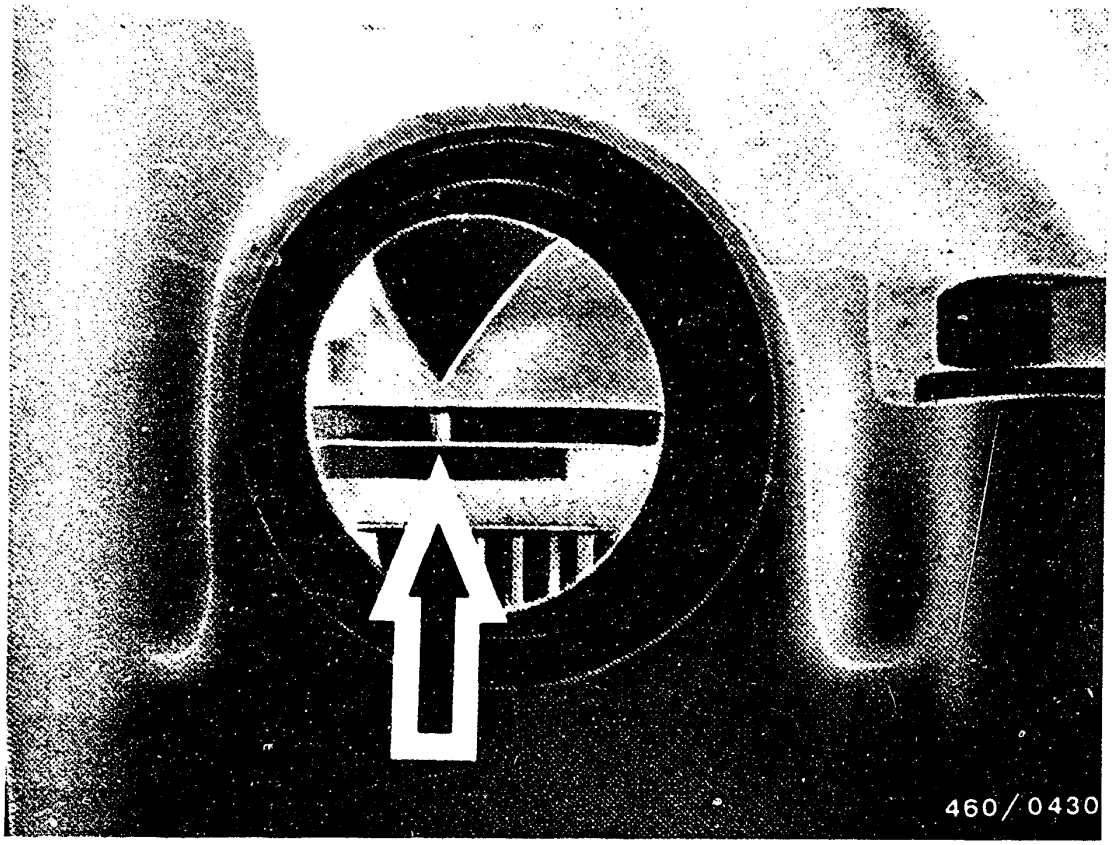
Operate starter without pre-heating.

Retighten vent screw when fuel escaping through injection pump vent hole is free of bubbles.



Continue to operate starter until fuel escapes at nozzle holder union nuts (arrow).

Tighten union nuts and operate starter until engine starts.



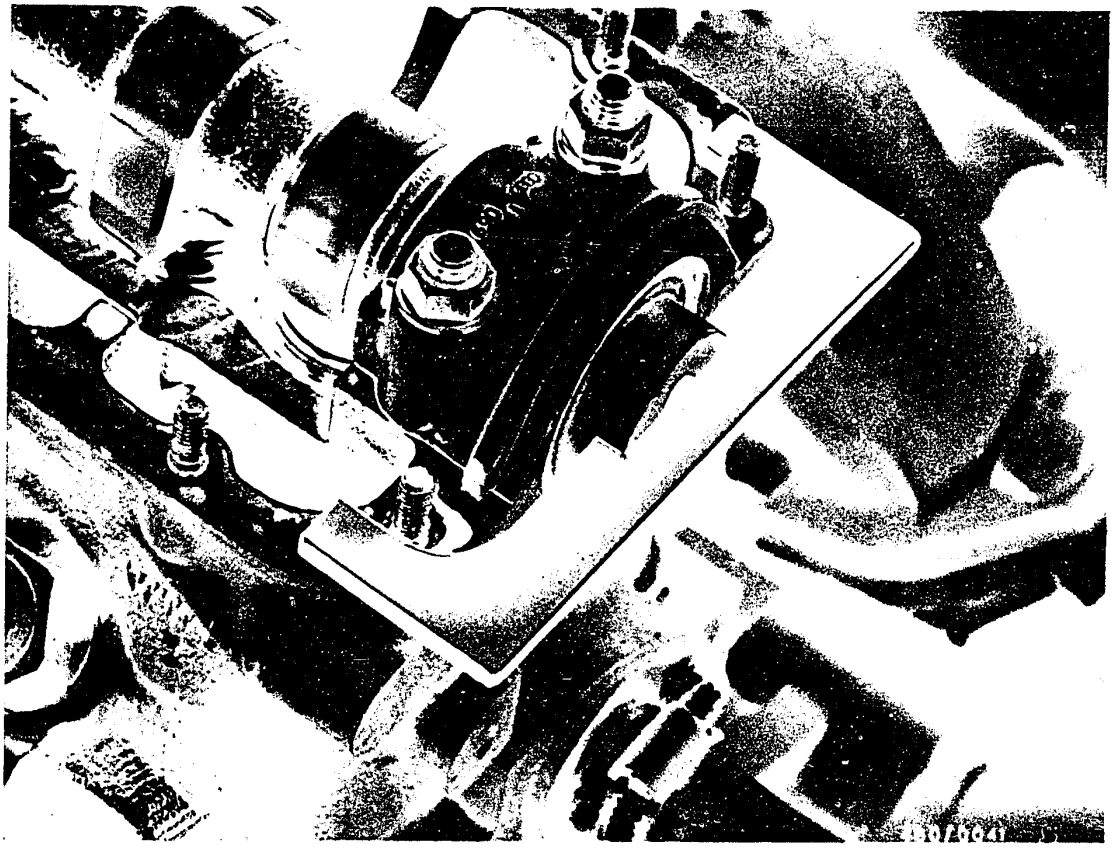
26. Checking and adjusting engine timing

26.1 Checking engine timing

Remove cylinder head and injection pump toothed belt guard.

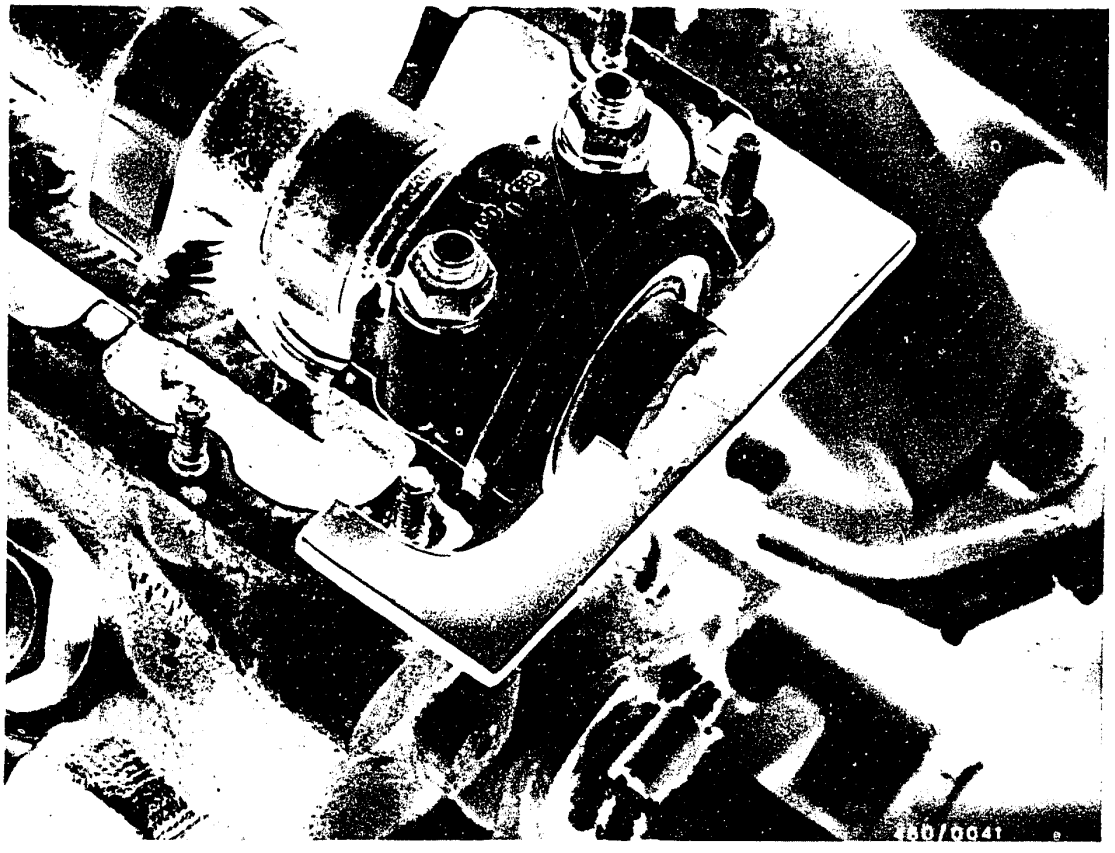
Rotate crankshaft until TDC mark (cylinder 1) on flywheel matches mating mark (shown at arrow above).

The marks on the injection pump sprocket and bracket must also coincide.



Slide KDEP 1117 setting straightedge into slot in camshaft.

If straightedge will not fit, timing is incorrect.

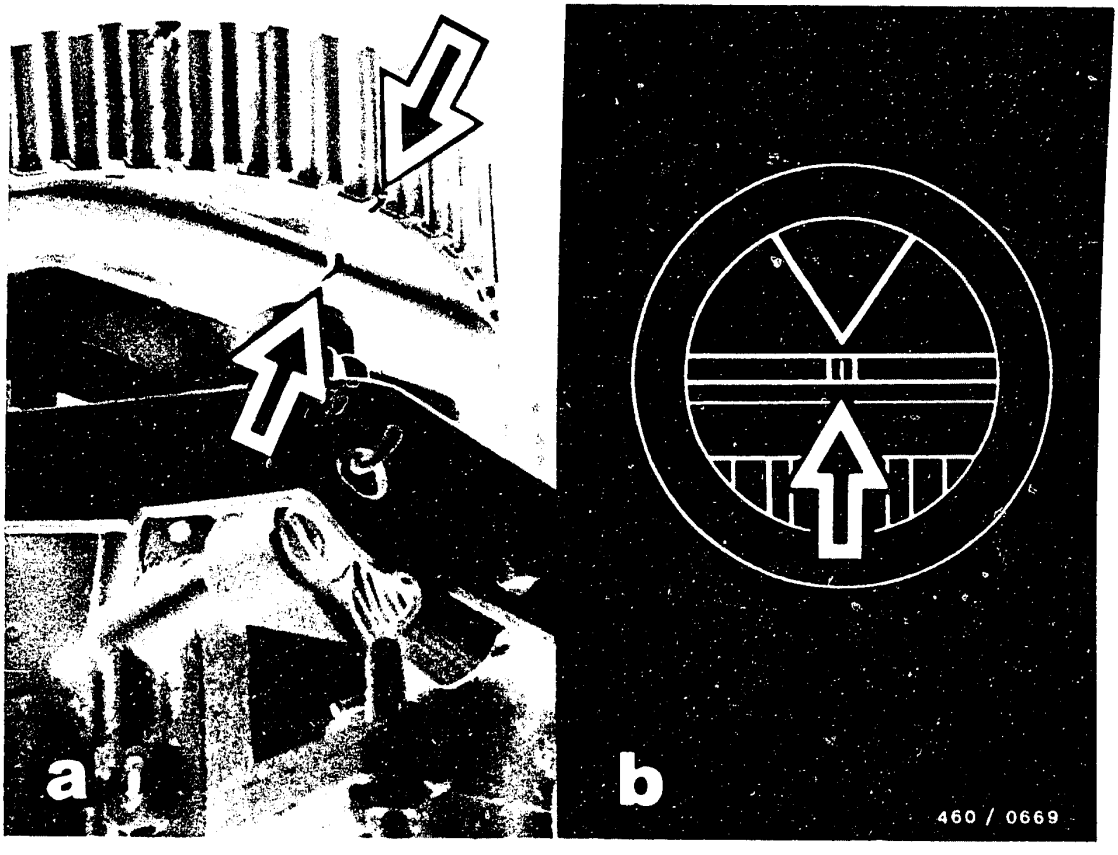


26.2 Adjusting engine timing

Rotate crankshaft so that setting straightedge fits into slot, and align as follows:

Rotate locked camshaft so that one end of straightedge rests against cylinder head.
Measure resulting clearance at other end of straightedge with a feeler gauge.

Divide clearance in half and insert feeler gauge of this thickness between straightedge and cylinder head.
Now rotate camshaft so that straightedge rests against feeler gauge.
Insert second feeler gauge of same thickness at other end between straightedge and cylinder head.



Unscrew camshaft sprocket mounting bolt ½ turn.

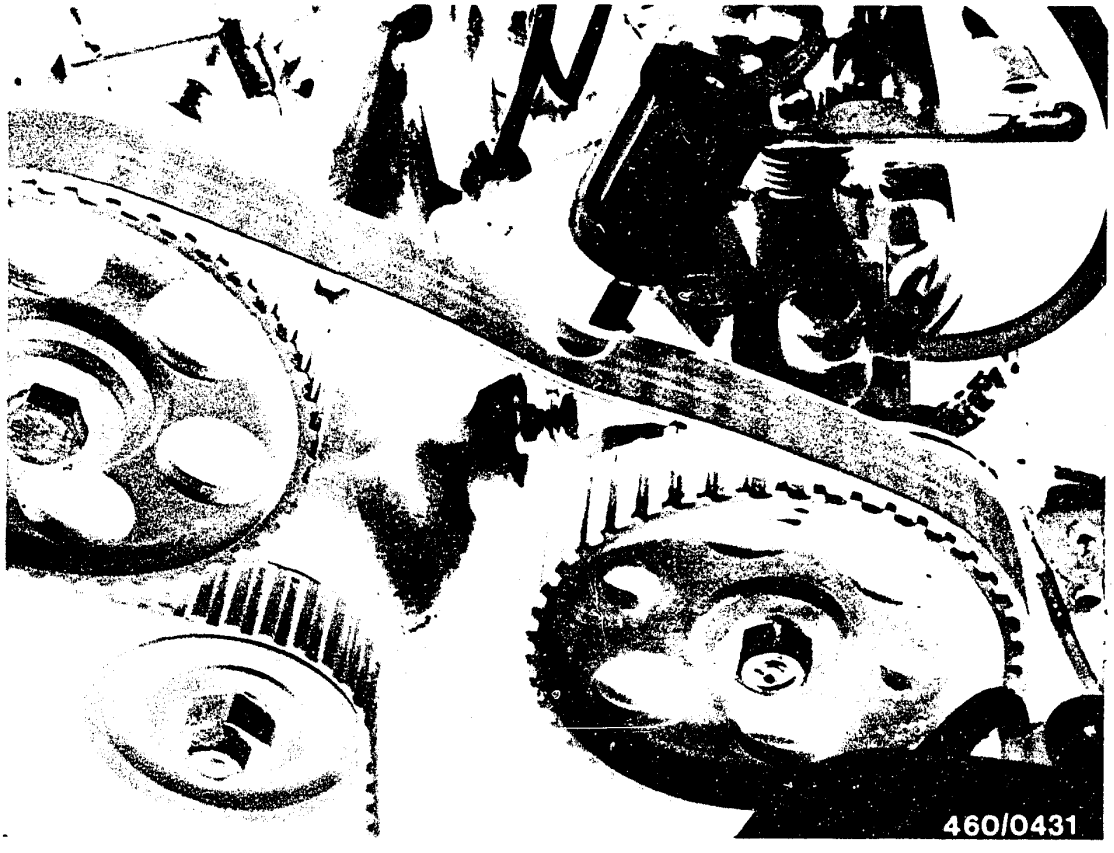
Loosen camshaft drive sprocket from conical seat by striking with rubber mallet.

Remove toothed belt.

Rotate crankshaft until TDC mark (cylinder 1) on flywheel matches mating mark (Fig. b).

Rotate injection pump sprocket so that marks on sprocket and bracket coincide (Fig. a).

Secure injection pump sprocket with KDEP 1122 securing pin (arrow).



Reinstall toothed belt.

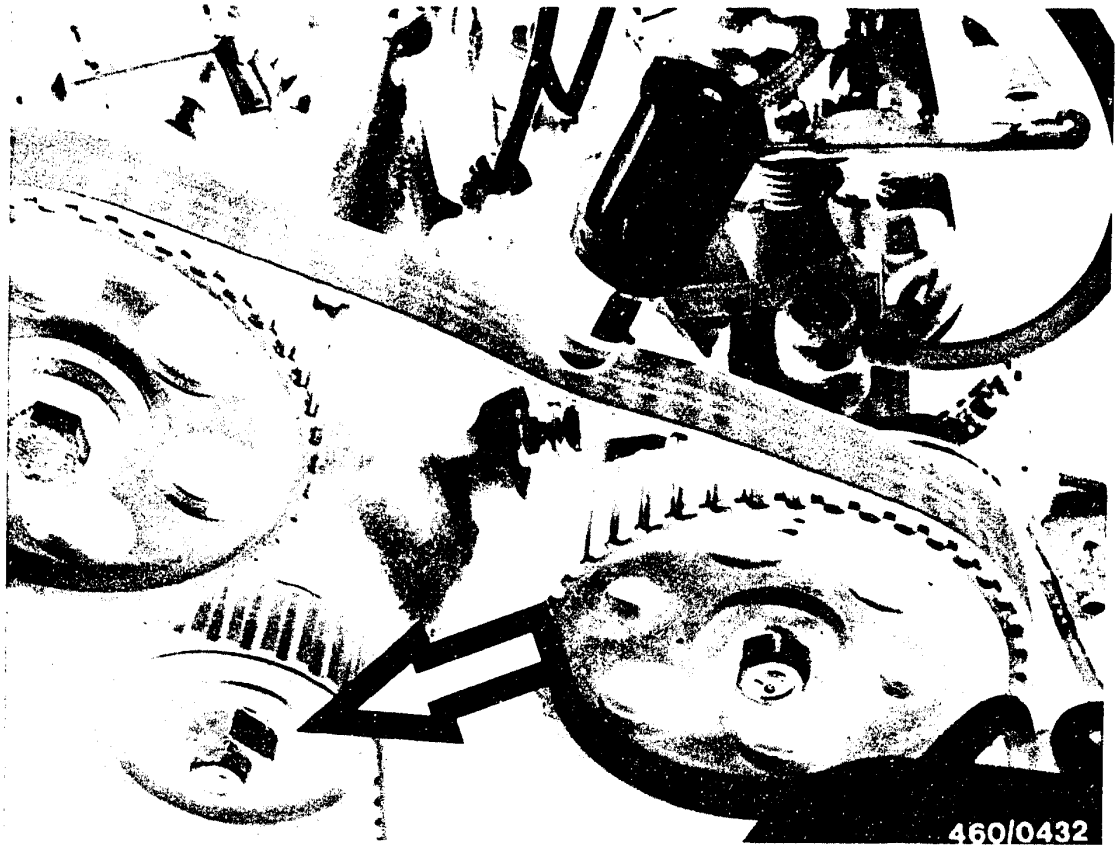
Remove KDEP 1122 securing pin.

Check toothed belt tension:

Mount KDEP 1121 belt tension checker (see photo).

Turn vernier sleeve until bottom sleeve edge coincides with marking on feeler.

Read off measurement: set value = scale value 12 - 13



If belt tension is not within this tolerance, adjust at tensioning roller (arrow); turn roller to right when making adjustment.

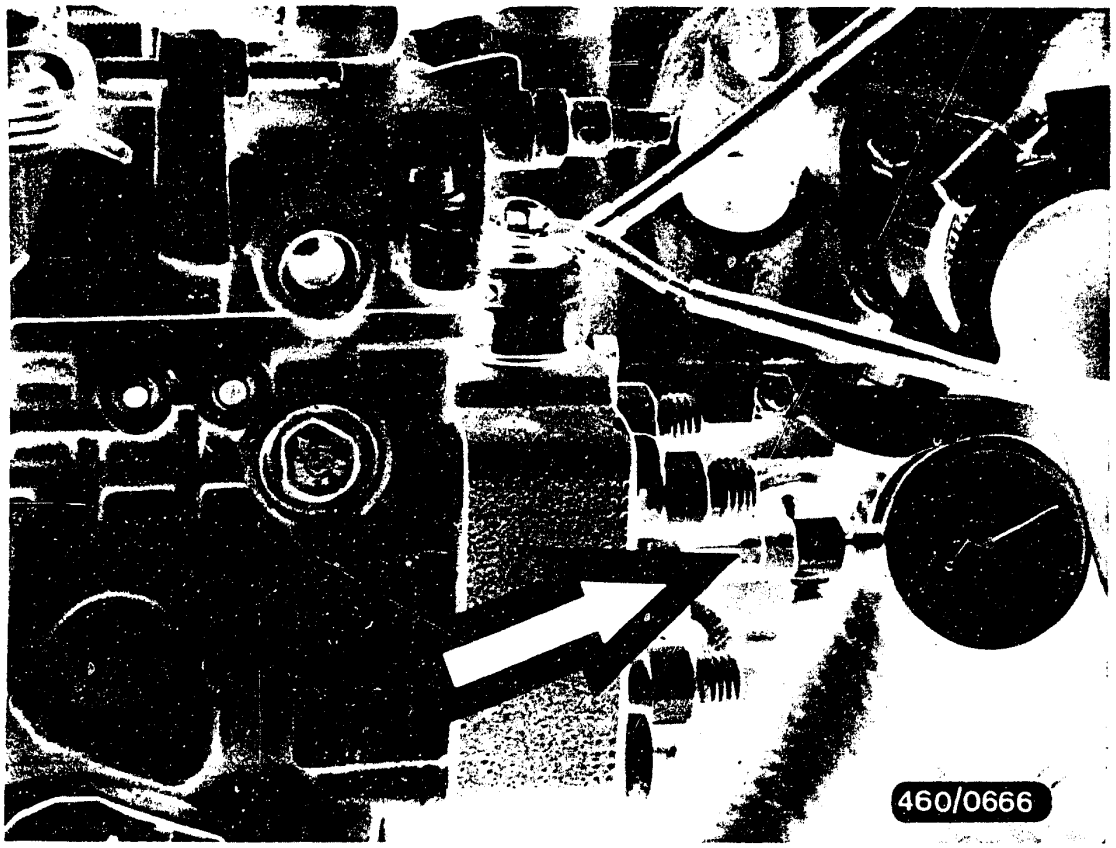
Note:

On 1.6 l engines use nut driver such as Hazet 2587.

Tighten camshaft sprocket to 45 Nm.

Remove setting straightedge.

Rotate crankshaft twice, then recheck toothed belt tension.



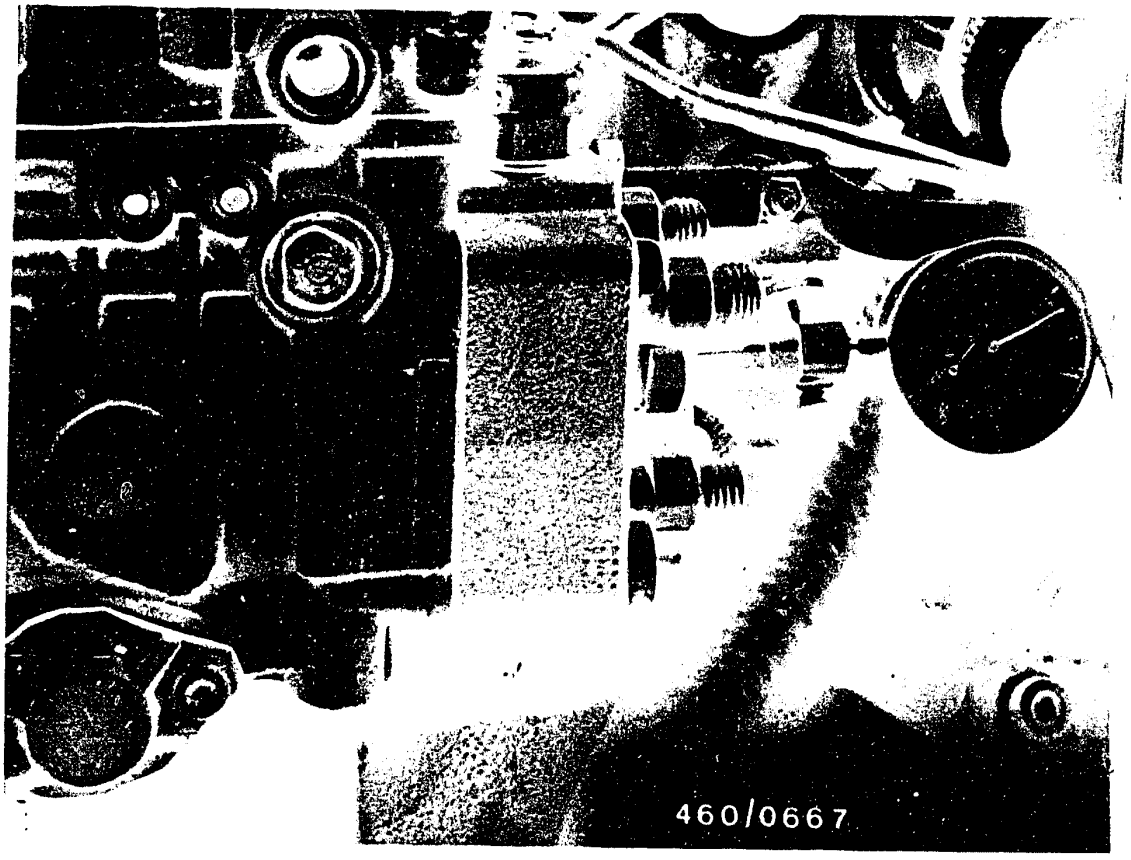
Remove injection lines at injection pump and nozzle holders.

Unscrew vent screw from plug (triangle-head bolt) in center of distributor head. (Back up delivery valve holders with wrench to prevent loosening.)

Screw KDEP 1085 measuring tool into vent screw hole (arrow).

Insert miniature dial indicator with measuring adapter into KDEP 1085 measuring tool.

Note:
Cold-start accelerator must be in zero position when checking and adjusting nominal start of pump delivery.



Preload dial indicator to approx. 2.5 mm.

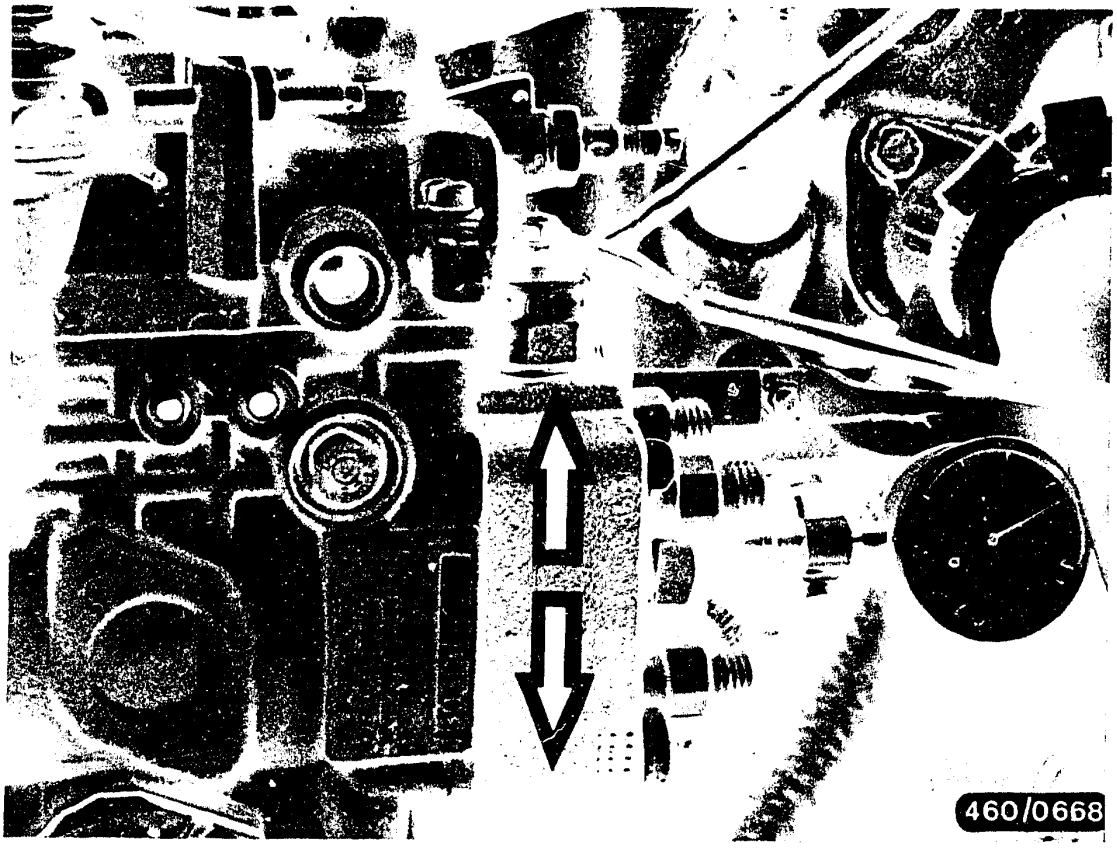
Rotate crankshaft slowly against direction of engine rotation until dial indicator pointer stops moving.

Preload dial indicator to approx. 1 mm and set to "0".

Rotate crankshaft in direction of engine rotation until TDC mark on flywheel and marks on injection pump sprocket and pump bracket coincide.

In this position, dial indicator must show following check values:

Diesel engine	0.78 ... 0.88 mm after BDC
Turbo-diesel engine	0.86 ... 0.97 mm after BDC



If retiming is necessary, loosen injection pump mounting bolts and swivel pump to following stroke:

Diesel engine	0.86 mm after BDC
Turbo-diesel engine	0.95 mm after BDC

Then tighten mounting bolts to 25 Nm, rotate crankshaft two revolutions and recheck setting.

Note:

The bottom mounting bolt on the bracket is screwed in from the drive side in the 1.6 l engine.

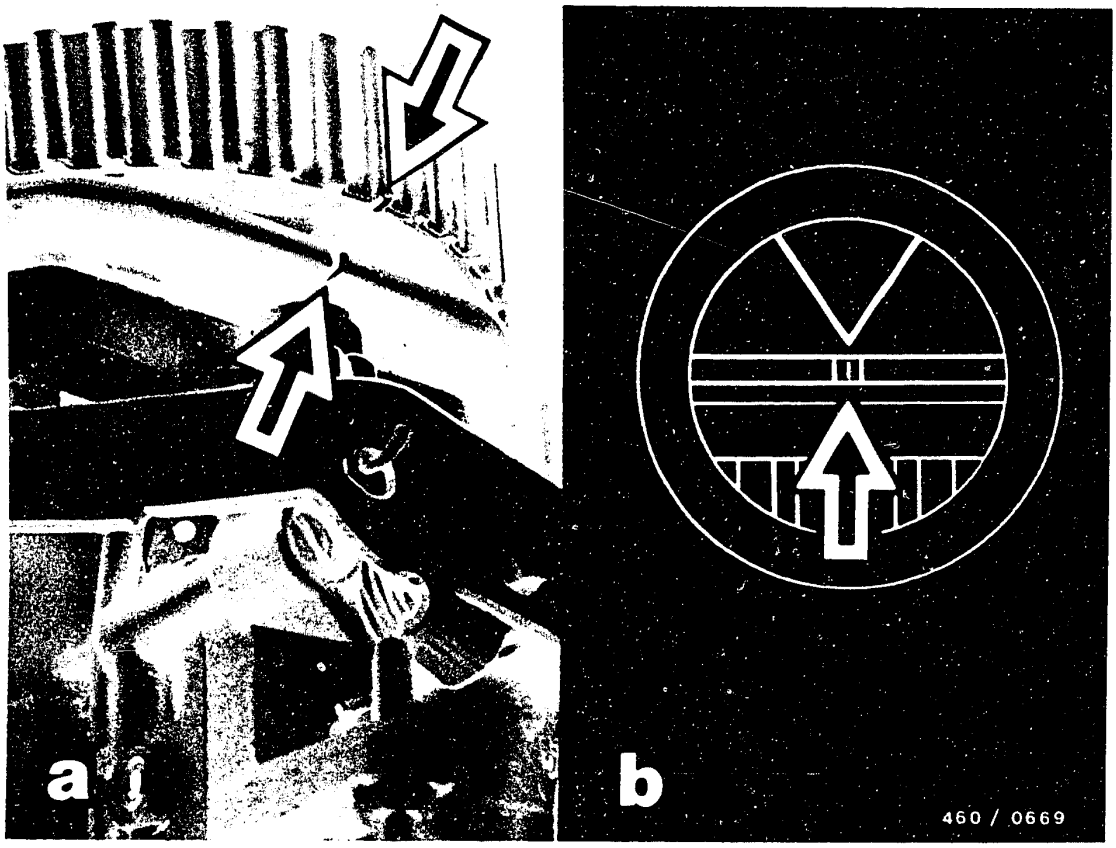
Remove KDEP 1085 measuring tool and dial indicator.

Replace vent screw with new gasket.

Tighten down injection pump support bracket.

Reconnect injection lines to injection pump delivery valve holders and nozzle holders.
(When tightening injection lines, back up delivery valve holders with wrench to prevent loosening.)

Reinstall toothed belt guard.

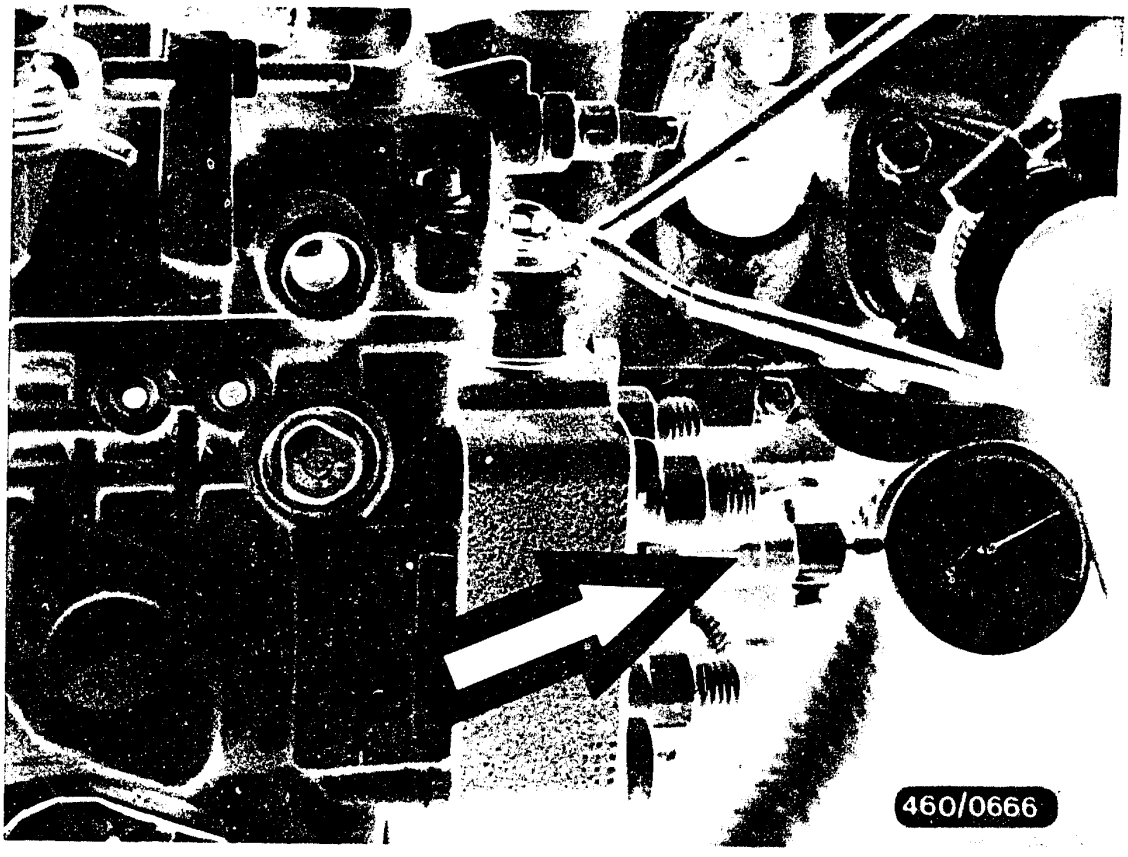


27. Injection pump/engine position agreement

Remove toothed belt guard for injection pump drive.

Rotate crankshaft until TDC mark (1st cylinder) on flywheel matches mating mark (Fig. b).

In this position the marks on the injection pump sprocket and bracket must coincide (Fig. a).



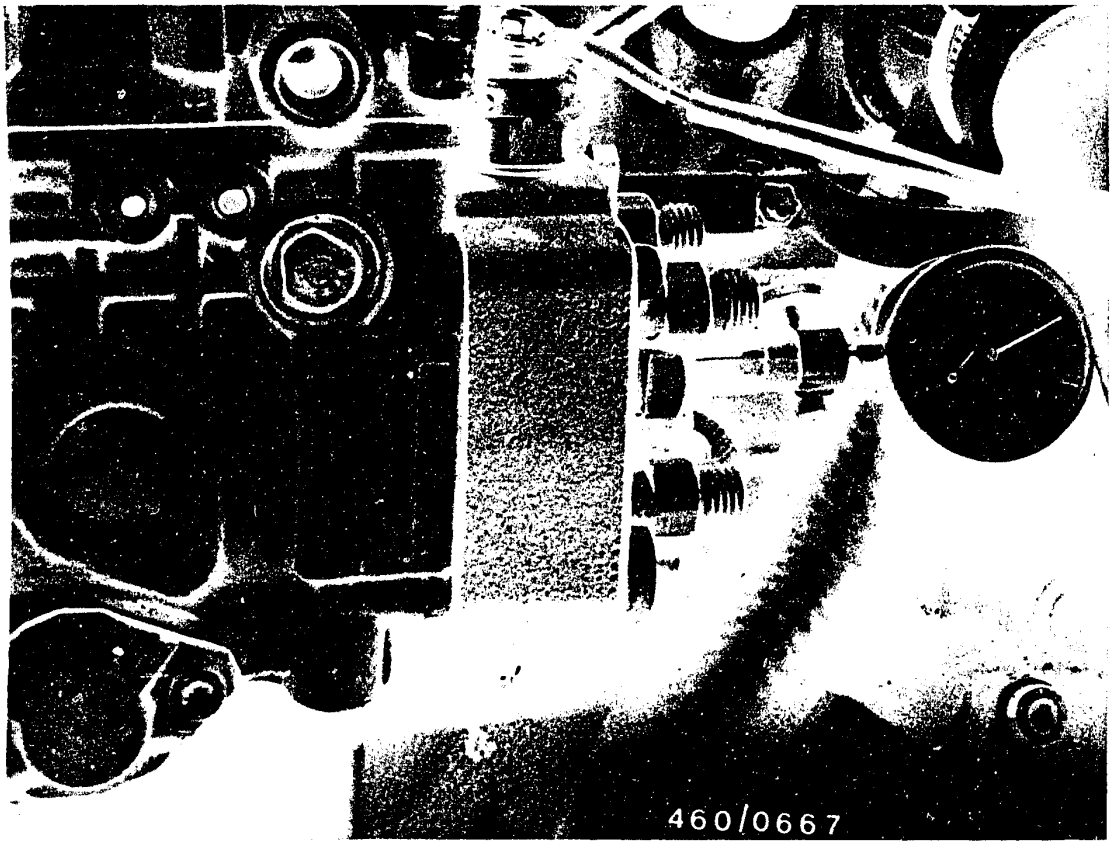
Disconnect injection lines at injection pump and nozzle holders.

Unscrew vent screw from screw plug (triangle-head bolt) in center of distributor head. (Back up delivery valve holder with wrench to prevent loosening.)

Insert KDEP 1085 measuring tool (arrow) into vent screw hole.

Insert miniature dial indicator with measuring adapter into KDEP 1085 measuring tool.

Note:
Control cable of cold-start accelerator must not be tensioned.



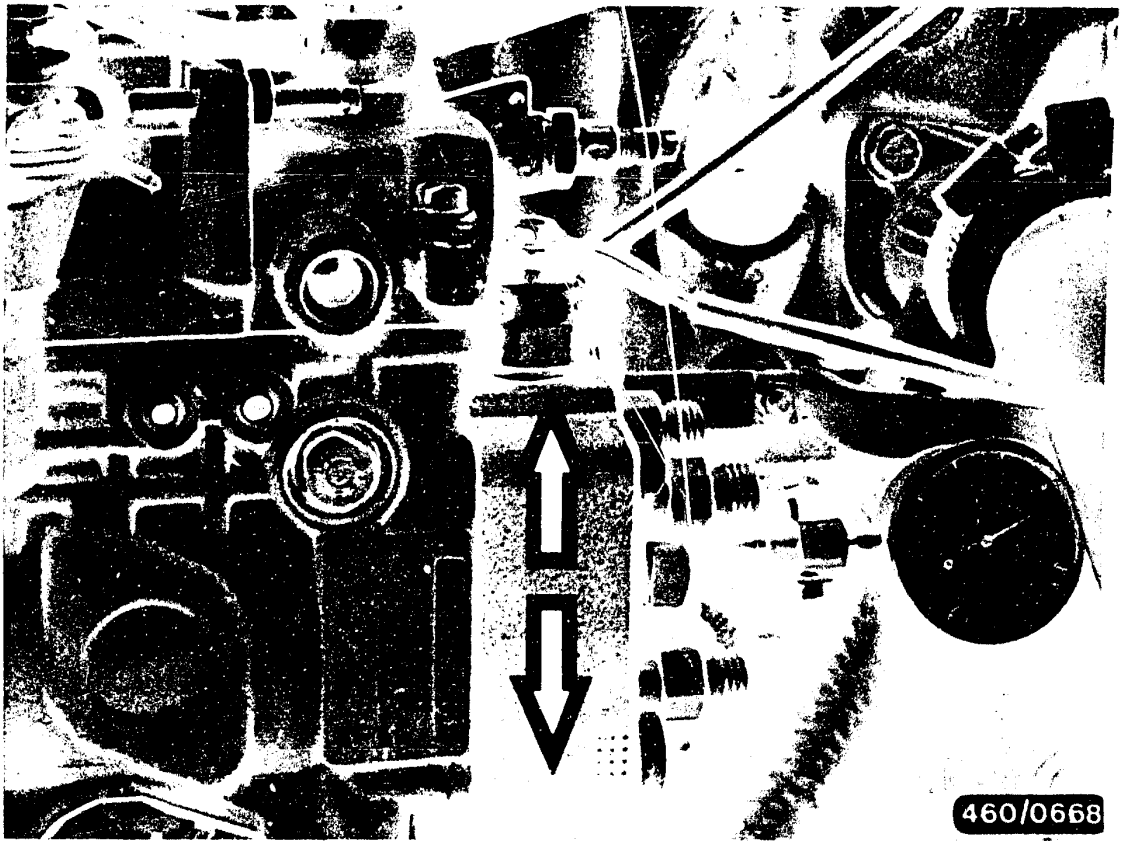
Preload dial indicator to approx. 2.5 mm.

Rotate crankshaft slowly against direction of engine rotation until pointer of dial indicator stops.

Preload dial indicator to approx. 1 mm and set to "0".

Rotate crankshaft in direction of engine rotation until TDC mark on flywheel matches mating mark.
In this position indicator must show following check values:

Diesel engine	0.78 ... 0.88 mm after BDC
Turbo-diesel engine	0.86 ... 0.97 mm after BDC



If correction is necessary, loosen injection pump mounting bolt and swivel pump to following stroke:

Diesel engine	0.86 ±0.02 mm after BDC
Turbo-diesel engine	0.95 ±0.02 mm after BDC

Then tighten mounting bolts to 25 Nm, rotate crankshaft two revolutions and recheck setting.

Note:

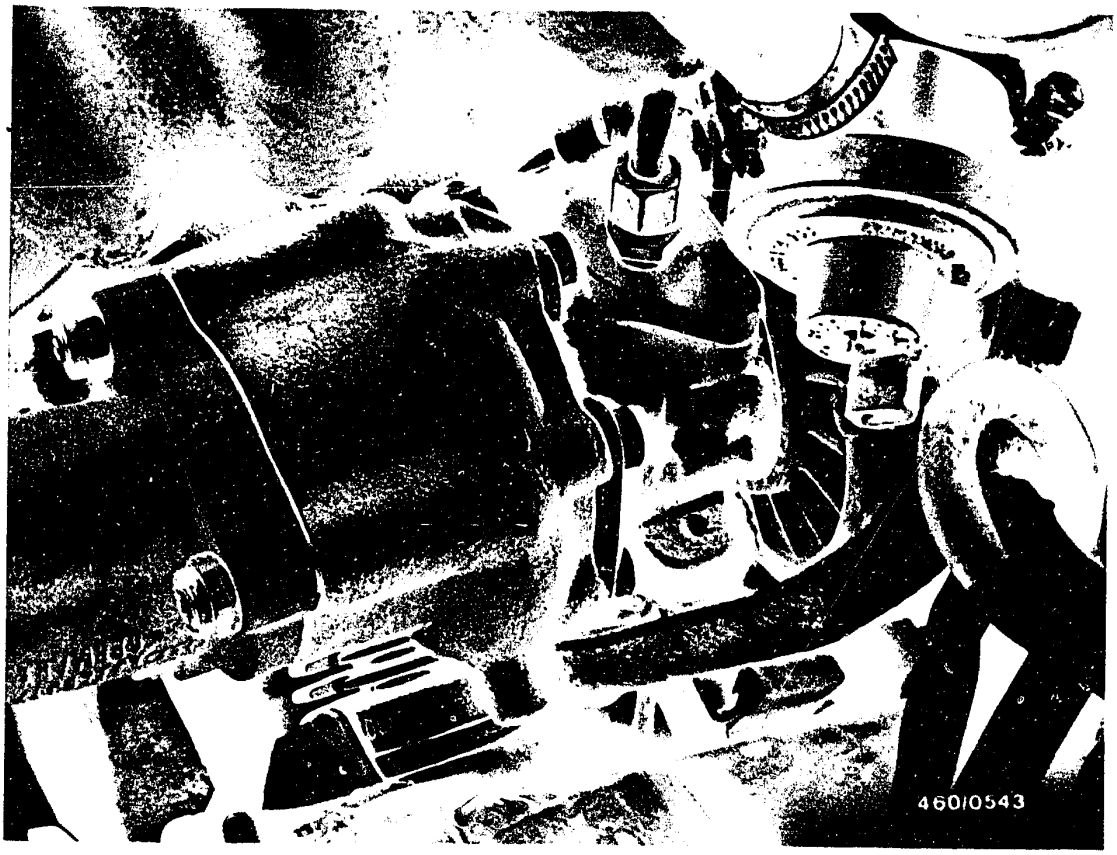
The bottom mounting bolt at the bracket is screwed in from the drive side in the 1.6 l engine.

Remove KDEP 1085 measuring tool and dial indicator.

Replace vent screw with new gasket.

Reconnect injection lines to injection pump and nozzle holders.
(Back up delivery valve holder with wrench to prevent loosening.)

Install toothed belt guard.



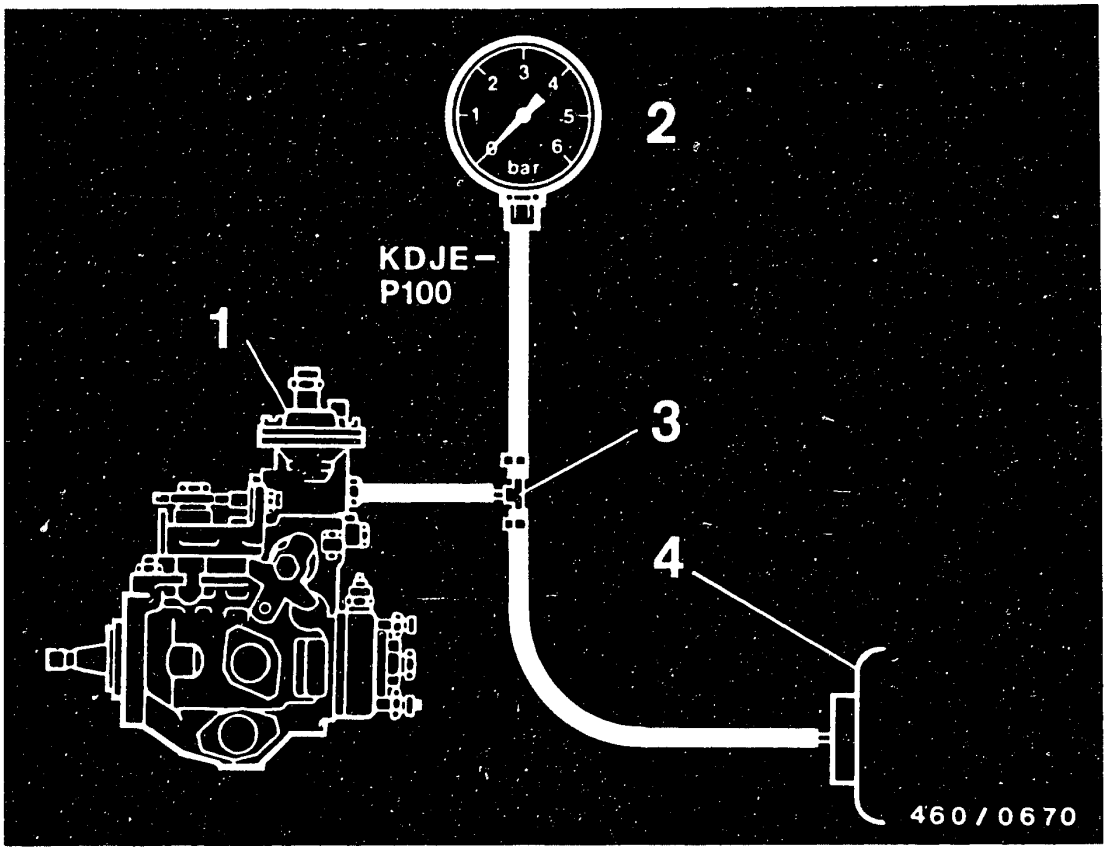
28. Checking charging-air pressure

When working on the turbocharger, keep in mind that it can be ruined by even the smallest particles of dirt!

For this reason, n e v e r run the engine without the air filter.

Note:

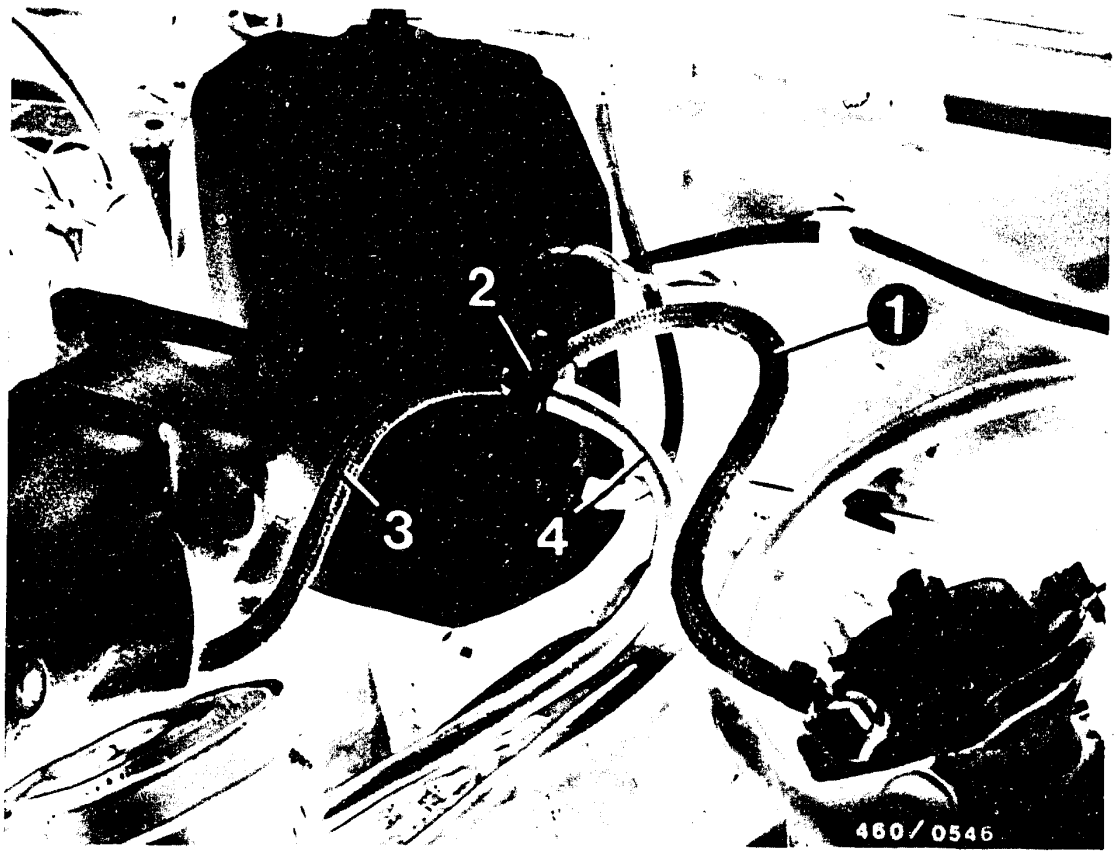
The hose connected to the charging-air pressure control valve must not be removed.
Removal of the hose can cause overcharging, which can ruin the engine at full load.



Charging-air pressure can be checked using pressure measuring instrument KDJE-P 100 or a pressure gauge with a range of 0 ... 1.6 bar (e.g. Wika No. 4184).

Connecting the KDJE-P 100 pressure measuring instrument

Disconnect one end of hose between charging-air tube (4) and manifold pressure compensator of injection pump (1). Remake connection using tee (3) supplied with pressure measuring instrument (2).



28.1.1 Connection of pressure gauge for measuring charging-air pressure

Remove hose (1) connecting charging-air tube and injection pump manifold pressure compensator at charging-air tube (arrow).

Insert tee (or "Y") into hose end (2).

Make connection to charging-air tube using piece of commercially-available hose (3).

Connect hose from pressure gauge (4) to tee (or "Y").

28.2 Measuring charging-air pressure

Charging-air pressure is measured at full load, either while driving or on chassis dynamometer.

Length of test per measurement max. 10 s

- On the chassis dynamometer:

 In 3rd gear or in 2nd driving range at 4000 min^{-1}

- While driving:

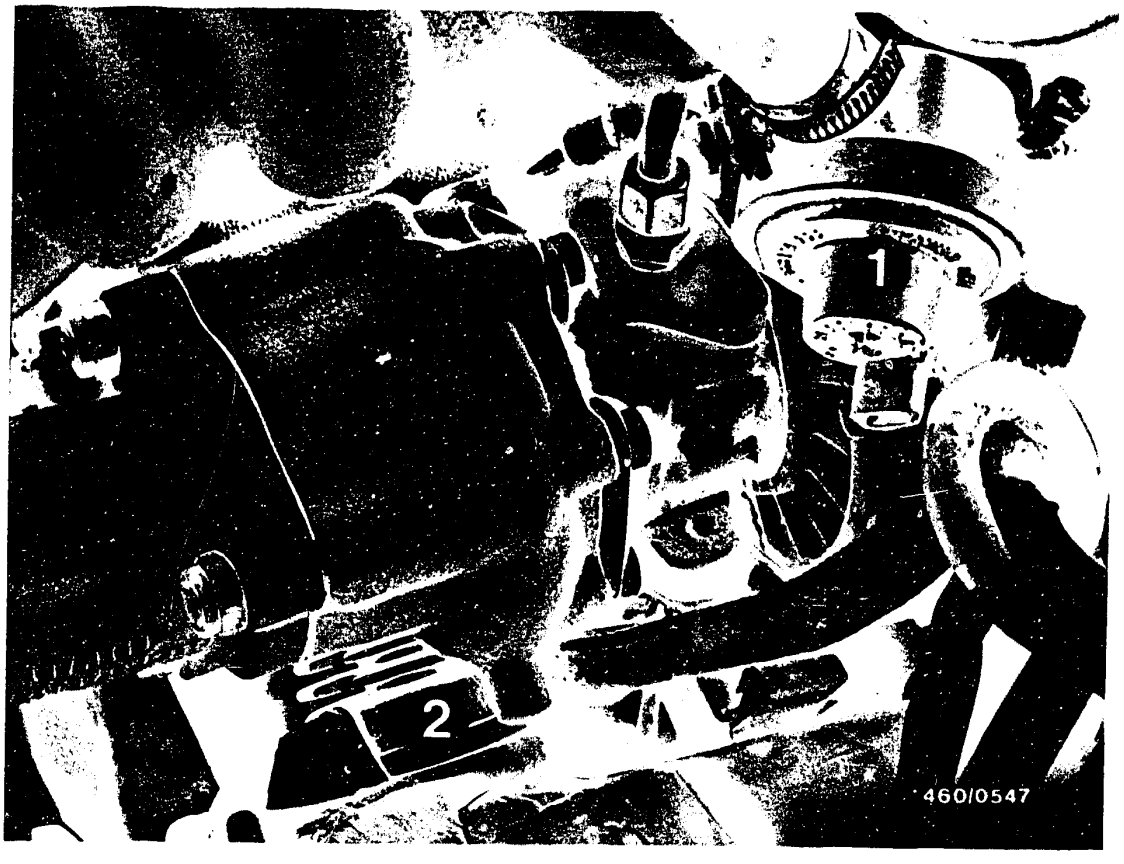
 In 2nd gear or in 1st driving range with simultaneous braking of vehicle to approx. 60 km/h.

Read charging-air pressure at pressure gauge.

Set value: 0.64 ... 0.72 bar

Note:

For proper evaluation of turbochargers, the nominal start of pump delivery and the nozzle opening pressure must be correctly set, suction and exhaust connections must be tight, and the engine must be in good mechanical condition (valve play, compression).

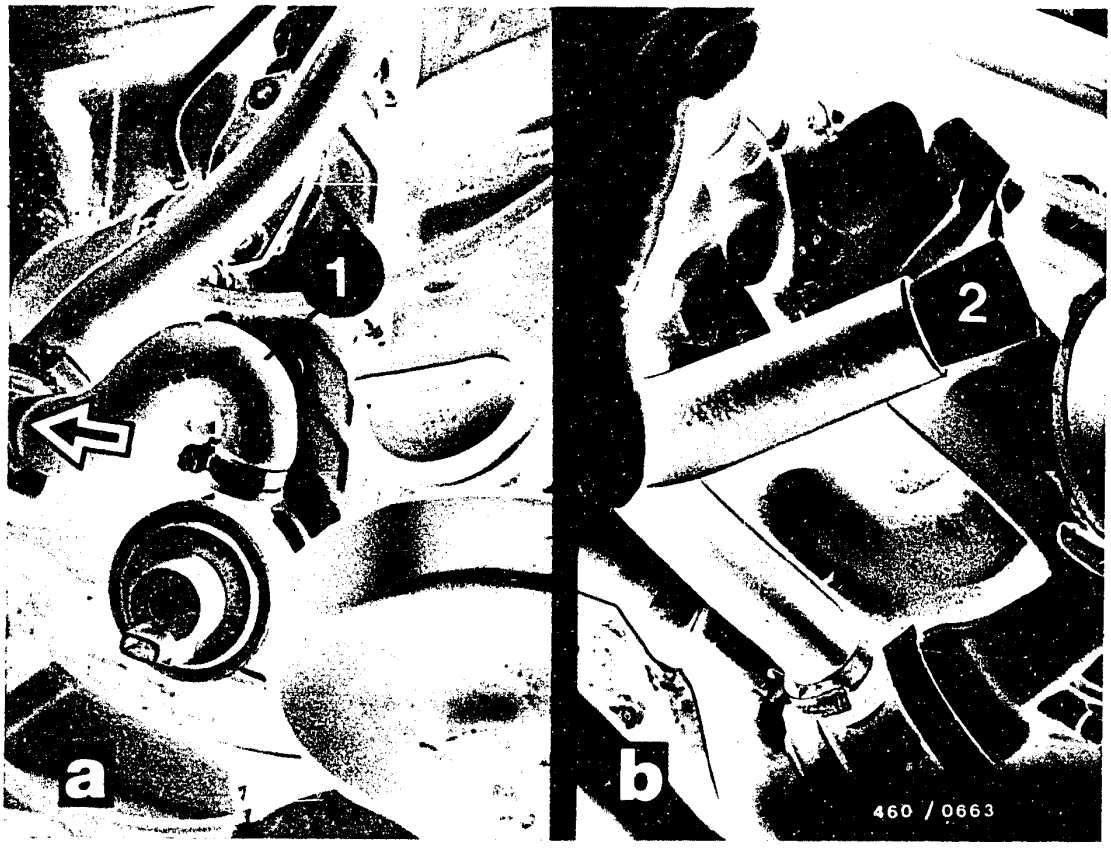


1 = Secondary-air valve

2 = Charging-air pressure control valve

28.2.1 Charging-air pressure too high

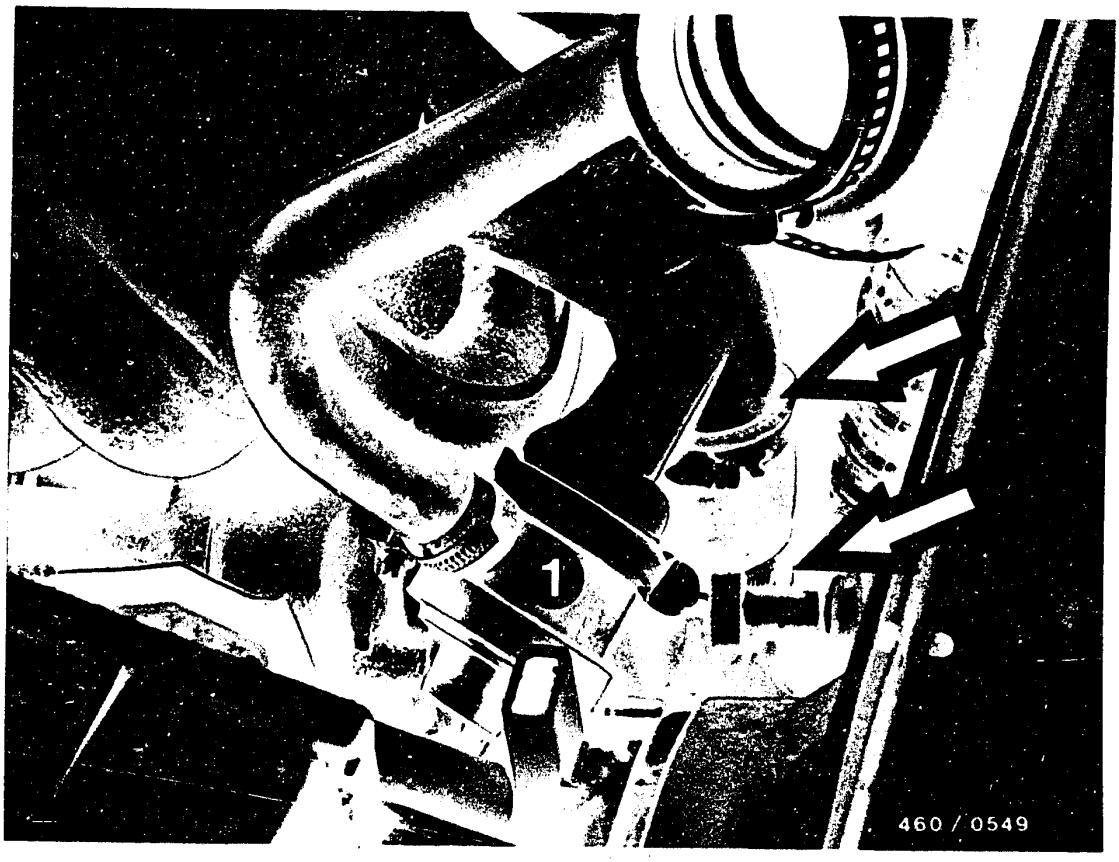
- Replace turbocharger.
 (charging-air pressure control valve defective)



28.2.2 Charging-air pressure too low (secondary-air valve check)

- Remove hose from secondary-air valve (1) to air intake hose (arrow) and insert plug (2) (user-fabricated plug, 25 mm dia.). Tighten hose clamp.
- Repeat check of charging-air pressure.
- Set value for charging-air pressure: 0.64 - 0.75 bar
 If set value is reached at this point, replace secondary-air valve.
- Charging-air pressure still too low
 Turbocharger defective -- replace.

Caution!
After installation of new turbocharger, allow engine to run for approx. 1 minute to ensure proper supply of oil to turbocharger.



29. Checking turbocharger for tightness

If charging-air pressure is too low, check following points for leaks:

- Gasket between charging-air tube and engine block
- Hose connecting charging-air tube and manifold pressure compensator (injection pump)
- Leaks at secondary-air valve (1)
- Hose connecting distributor outlet and charging-air tube (arrows)
- Gasket between charging-air pressure control valve and turbocharger
- Gasket between exhaust manifold and engine block

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